US Army Corps of Engineers
Construction Engineering Research Laboratories

USACERL Technical Report 95/34
September 1995

Studies for the Development of a Space Utilization Index

by
Charles G. Schroeder, Joyce Baird, K. Bret Roberts, and Gordon L. Cohen

This report presents the findings of a study to determine the feasibility of developing a space utilization indexing methodology for Army facilities. The objective of this methodology would be to provide Army planners a reliable indicator of how effectively real property is being utilized. A properly developed index, compiled from timely, accurate data and including adjustment factors to compensate for special space utilization circumstances at given facilities, could enable planners to compare space utilization Army-wide or within a Major Army Command (MACOM). Such a capability could enhance space utilization decisions as the Army continues to use its real property more efficiently and effectively.

The findings of a literature search indicated that no valid space utilization indexing method now exists. The authors developed and tested a prototype indexing methodology based on a ratio analysis method. This prototype, called RAM 1, was not effective due to constraints inherent in the problem of indexing the utilization of diverse spaces.

More complex algorithms and adjustment factors might be developed, but the authors conclude that this approach could compromise the index's integrity or credibility. An economics-based approach and benchmarking are proposed as two possible alternatives to a purely statistical indexing approach.

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave Blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 1995	Final

4. TITLE AND SUBTITLE
Studies for the Development of a Space Utilization Index

5. FUNDING NUMBERS
4A162784
AT41
SB-AQ1

6. AUTHOR(S)
Charles G. Schroeder, Joyce Baird, K. Bret Roberts, and Gordon L. Cohen

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Construction Engineering Research Laboratories (USACERL)
P.O. Box 9005
Champaign, IL 61826-9005

8. PERFORMING ORGANIZATION REPORT NUMBER
TR 95/34

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Office of the Chief of Engineers
ATTN: DAEN-ZCI-P
20 Massachusetts Ave. NW
Washington, DC 20314-1000

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)
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14. SUBJECT TERMS
Army facilities
space utilization
facility management

15. NUMBER OF PAGES
64

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

Foreword

This study was conducted for the Office of the Chief of Engineers (OCE) under Project 4A162784AT41, "Military Facilities Engineering Technology"; Work Unit SB-AQ1, "Facility Utilization Index Methods." The OCE technical monitor was Randy Klug, DAEN-ZCI-P.

The work was performed by the Business Processes Division (PL-B) of the Planning and Management Laboratory (PL), U.S. Army Construction Engineering Research Laboratories (USACERL). Moonja P. Kim is Acting Chief, CECER-PL-B, L. Michael Golish is Acting Operations Chief, and David M. Joncich is Chief, CECER-PL.

COL James T. Scott is Commander and Acting Director of USACERL, and Dr. Michael J. O'Connor is Technical Director.

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1 Introduction

Background

Concern about U.S. Army facility space utilization began in the context of an energy conservation initiative. In looking at ways to measure facility space utilization in terms of energy conservation, the Department of the Army (DA) recognized the lack of a uniform system for measuring facility utilization and comparing utilization rates across Army installations nationwide. To meet the needs arising from the Base Realignment and Closure (BRAC) initiative and the concurrent decrease in new construction, it is important that all installations assess their facility utilization to ensure that facilities are being used efficiently and effectively. Underutilized facilities may be considered for renovation, conversion, or disposal.

In the effort to develop a method for measuring and comparing facility utilization rates across Army installations, the U.S. Army Construction Engineering Research Laboratories (USACERL) used statistical analysis as the basis for creating a facility space utilization index (UI). The goal was to develop a method that could be used to measure and compare as accurately and fairly as possible the relative utilization rates of Army installations nationwide. One of the outcomes of efficiently measuring utilization may be the consolidation of activities into underutilized space, leading to dollar savings in energy and maintenance costs. If, on the other hand, space is overutilized, reassignment of activities to other facilities may improve morale and safety. Overcrowding is undesirable and must be considered an important factor when looking at efficient space utilization.

A space utilization index theoretically could be used as a basic indicator of an installation's relative performance in efficiently using its space. A space utilization index might also increase command accountability by enabling easy comparison among installations nationwide. The comparison of space utilization at the installation level could become the basis of an Army-wide program to recognize installations that best utilize their facilities.

Before the benefits of a space utilization index could be realized, several roadblocks to the development and implementation of such a tool had to be addressed. If the implementation of an installation utilization index was to be feasible, its benefits had

to outweigh its deficiencies. If the proposed index did not remove enough roadblocks (or mitigate their effect) or did not fulfill its main objective, it would not be feasible or desirable to implement. However, if an indexing method could be developed to effectively compare space utilization nationwide while addressing the most serious roadblocks, implementation might be possible.

Objective

The objective of this research was to develop a method for determining the relative utilization of facility space at U.S. Army installations, according to space type.

Approach

This work was accomplished in five phases:

First, the researchers conducted a computer-based literature search for similar projects or helpful guidelines in developing a space utilization indexing method. No proven method was found during the literature search, but related material collected at this time was used for background and perspective in evaluating all alternative methodologies later investigated.

Second, the ratio analysis method was used to develop a prototype indexing methodology called RAM 1. This phase of the research was an iterative process of development and evaluation. Most problems with RAM 1 were related to the requirement that the indexing methodology be implemented on a nationwide basis. The methodology must be flexible enough to adjust utilization rates on the basis of an installation's unique characteristics. On the other hand, a method with too much flexibility—one offering too many adjustment factors—probably would not provide a valid basis for comparing utilization rates nationwide and across Major Army Commands (MACOMs). Every iteration of RAM 1 was subjected to the criteria discussed under "Roadblocks to Implementation" (Chapter 4). In this way, the potential of different approaches could be evaluated theoretically before they were fully tested on real or simulated data.

Third, RAM 1 was pilot tested using both simulated data and real-world data from administrative buildings at USACERL. The data collected included net square feet of space, conference room schedules, and building occupancy. RAM 1 algorithms were applied to the data to yield a utilization rate for each building. These algorithms and definitions of the variables used are included in Appendix A. The test on simulated

data is reported in Appendix B, and results from the USACERL data are reported in Appendix C. The simulated data were entered into a questionnaire (Figure B1) and the *Work Space Management Plan and Budget Justification Form* (General Services Administration [GSA] Form 3530). The preliminary evaluation of this method led to the decision that the utilization rate should be calculated using empirical data and a statistical model that rates an installation's facility utilization against other installations rather than against some theoretically ideal utilization rate.

Fourth, a trial run of RAM 1 was conducted using data provided by two Army installations in response to informal questionnaires. (Requests also were made to the General Services Administration [GSA] and Army offices where other potential data for the UI are filed, but no useful responses were received.) In addition, USACERL researchers visited several Army installations to obtain data and to interview installation real property and space management personnel.

Fifth, the authors used all valid space utilization data obtained in the research to develop a standard normal deviation statistical model. If effect, a "grading curve" was developed to propose a real-world baseline for "optimal" space utilization at Army installations.

Scope

This study focused on space utilization in administrative facilities. The Real Property Management Program (RPMP) Executive Steering Committee, formed by Headquarters, Department of the Army (HQDA) with assistance from USACERL, identified administrative space as the highest priority for indexing. (Other types of space considered included land, classroom and training space, storage space, barracks, and equipment maintenance space.)

The researchers developed a utilization indexing method, but due to the variation of administrative facilities within an installation and across installations, lack of personnel at installations to use the indexing method, and the cost and difficulty of obtaining required data, the investigators looked at alternative means of approaching the problem. Alternative methods that were considered include the benchmarking process and the feasibility of developing an algorithm that measures the cost per square foot of space per unit of measure (e.g., per person, per cubic foot of storage space, etc.).

Mode of Technology Transfer

Technology transfer of any methodology for quantifying space utilization should be accomplished by incorporating the methodology into the Army installation space management program developed by the RPMP Executive Steering Committee. This committee includes representatives from Headquarters, Department of the Army, MACOMs, the U.S. Army Center for Public Works (USACPW), selected Army installation real property and space management personnel, and private-sector contractors.

Metric Conversion Factors

U.S. standard units of measure are used in this report. A table of metric conversion factors can be found below.

1 ft	=	0.305 m
1 sq ft	=	0.093 m^3
1 cu ft	=	0.028 m^3
1 ton (short)	=	907.1848 kg

2 Literature Search

A computer-based literature search did not reveal any specific space utilization indexing methods currently in use, but did reveal that effective, efficient space utilization and facility management are high priorities to both corporate and facility managers. Material summarizing the goals of effective space utilization was useful to the authors when considering alternatives to indexing space utilization that might accomplish a similar goal—improved space utilization—through a different methodology. One methodology being considered as a possible alternative to indexing—benchmarking*—was the subject of a supplementary literature search in a later phase of this study. The findings of that search also are reported in this chapter.

Space Utilization Findings

At an executive forum conducted by the Facility Management Institute in Los Angeles, October 1983, Peter Drucker stated that facility management must seek to understand, integrate, and manage all of the elements of the work environment, including human resources, the work processes, and the physical workplace, to optimize conditions to allow effective work to occur (Drucker 1983). At the same meeting, John H. Barnard, Jr., from the Bechtel Group, Inc., spoke about the problems of measuring effectiveness in workplace facilities and using human resources properly to manage facilities. He said that, in the broad sense of the term, a facility constitutes the integration of people, process, and place.

Brill et al (1991) discuss using the design of space to increase productivity, and point to the difference between density (the measure of floor area per person) and occupancy (the number of individuals whose workstation is in a room). Although occupancy and density are not the same, they are often related to one another. Brill states that due to the tight economics of facility management, if a workforce shrinks, there is continued pressure toward occupancy at higher—not lower—levels.

* Benchmarking: ongoing quantitative weighing of an organization's processes against those of other organizations to promote continuous improvement.

Phelps and Baxter (undated) assessed space utilization in a large university academic department through a multivariable, multimethod information-generating system. Data on the organization's goals, user attitudes and needs, and existing behavior patterns were gathered from structured interview, questionnaire survey, and behavioral observation. The results produced information about departmental goals that might have implications for space utilization and allowed the assessment of user satisfaction with current facilities.

A utilization study should be conducted when a company decides to expand its present facilities. An effective study will show which departments are overcrowded, where surplus space exists, which groups are improperly placed causing fragmented operations, slack space, and poor circulation. Allocations in a specific facility where problems have been identified should be compared to other facilities and to optimal units. Densities for each facility (or floor of a facility) may be calculated and used as a basis for comparison. Space deficiencies or surpluses can be identified by matching the space used for each function with the net area assigned to it (Gould 1983).

Shoshkes (1976) discusses the variable factors in space planning: identifiable work units (groups) and realistic planning periods. Identifiable work groups provide information about a finite number of people. Information about realistic planning periods is based on knowledge of the present, projected size of the organization in new facilities, and maximum growth to be accommodated.

Applicability of Benchmarking to Space Utilization Issues

Richard Weirich, assistant postmaster general for information resource management, has indicated that the computer and network services department of his organization uses benchmarking to improve its performance. Weirich found a commercial company that had compiled a database of 100 large organizations' performance in delivering computer services, and his organization used the data and applied the same measures. The study showed areas in the department that needed reworking and those that were doing well. The U.S. Postal Service is planning to apply benchmarking to its telecommunication department (Rogers 1991).

Another private-sector company, Real Decisions Corp, has developed benchmarks for performance and cost-effectiveness of information systems organizations, and maintains a large database of performance metrics. Many organizations are using these data to improve their own performance (Eckerson 1991a).

A number of organizations consider benchmarking to be an essential component of total quality management (TQM) programs because its main goal—like TQM—is process improvement. Others believe benchmarking to be an essential criterion associated with the Malcolm Baldrige National Quality Award (Whiting 1991). Eckerson (1991b) suggests that many organizations may adopt formal peer-to-peer benchmarking as a viable tool for evaluating their own products.

Two basic steps toward process improvement in an organization are analysis and benchmarking. Most companies do not have measurement processes by which they can conduct analytical studies of their processes. Benchmarking requires finding an organization that excels and applying its standards and methods to a less efficient organization (Card 1991).

Benchmarking involves two primary elements: locating *dantotsu* (the Japanese term for "the best of the best" in a specific industry) and identifying what makes that organization the best. There are three ways of approaching benchmarking: (1) pay a consulting company to use its database to draw comparisons between the *dantotsu* and the client organization, (2) solicit a bid for a product or service from an organization in the same line of work, then compare one's own budget for the same scope of work, or (3) conduct benchmarking to address the issues of process, productivity, and other relevant performance parameters (Walsh 1992).

Modeling is applied to computers, networks, hardware, and software for two purposes: (1) measuring the quality of an application or device against its peers, and (2) finding the most effective way to arrange the parts of a process or product. In these senses benchmarking can also be considered a type of modeling; it compares process and performance measures of one company to another, or to an external norm (*Tech Street Journal* 1991).

Benchmarking is a necessary part of evaluating information technology products and their potential. But often, benchmarking is performed on the wrong devices and some important aspects are ignored. Benchmarking may even be dangerous if care is not taken to ensure that it is performed carefully and that what it is measuring represents the technology's function and potential use (Schmall 1992).

Concurrent engineering emphasizes simultaneous and integrated product design and development. Companies that use this process also tend to use competitive benchmarking to establish performance goals. Concurrent engineering produces products quickly, economically, and in a user-oriented way (Meth 1992).

Camp (1989) defines benchmarking as industry's search for the best practices that will lead to superior performance. It is a continuous process of self-improvement, and cannot be applied once and discarded. Camp also maintains that benchmarking measurements can be applied to all areas of a business. Benchmarking can credibly qualify and justify a manger's operations because it constitutes a proactive search for the best "role models" in the industry. Benchmarking documents and affirms that the manager is measuring his or her organization's activity against the toughest real-world standards.

Camp does not cite cases of using benchmarking for measuring facility utilization, but the key steps in the process are general, and nothing in them would preclude their application to improvement of facility utilization. According to Camp, the five phases required to implement benchmarking are:

1. Planning
   - Identifying what is to be benchmarked
   - Identifying to whom or what it will be compared
   - Determining how the data will be collected.

2. Analysis
   - Understanding current practices and those of benchmarking partners
   - Seeing what the benchmarking partner does better
   - Understanding why they are better and by how much
   - Understanding how their practices can be modified for implementation.

3. Integration
   - Gaining operational and management acceptance
   - Communicating benchmarking findings to all organizational levels
   - Converting benchmarking findings into a statement of operational principles to which all of the organization can subscribe.

4. Action
   - Converting the benchmarking findings and operational principles based on them to action.
   - Making sure that milestones are included for updating the benchmark findings.

5. Maturity
   - The best industry practices are incorporated into everyday operations
   - Benchmarking becomes an ongoing, essential, and self-initiated facet of the management process.

Anthony Pedalino, Vice President of Facilities at NBC, has applied benchmarking to the facility management profession (McMorrow 1992).

3 Preliminary Assessment of Possible Indexing Methodologies and Data Sources

Statistical Approaches to Indexing

The authors considered several different statistical approaches upon which to base a UI methodology. These approaches may be grouped into two categories: (1) ratio analysis and (2) regression analysis.

Ratio Analysis

Several ratio analysis methods were reviewed. Each alternative was evaluated against the considerations discussed in Chapter 4. To fulfill its purpose, the indexing method had to show the potential to overcome many of the inherent roadblocks, as discussed in Chapter 4.

No existing ratio analysis method was found that could meet the objectives of the type of UI that is needed. Consequently, USACERL developed a new ratio analysis method—called RAM 1—which seeks to balance fairness and accuracy with simplicity and ease of implementation. RAM 1 is described in Appendix A.

RAM 1 permits the use of adjustment factors at the building level and below. (Appendix D discusses how to use adjustment factors.) Of all the statistical approaches examined in this research, RAM 1 offers the best basis for a UI. The major drawback of RAM 1 is that it cannot effectively use data captured by installation real property managers on GSA Form 3530 or the *Installation Commander's Annual Real Property Utilization Survey* (ICARPUS), as discussed below under "Sources for Installation Space Utilization Data." Instead, RAM 1 requires installation personnel to fill out a new form specifically developed for the methodology (Figure B1). However, the RAM 1 form would not have to be filled out for every building on an installation. Possibly 10 to 20 randomly selected buildings per installation would be enough for a representative sample. Guidelines would have to be developed for determining the specific selection of buildings to be surveyed.

Regression Analysis

Another methodology—regression analysis—was considered for developing a facility utilization indexing method. A wide variety of uses for regression analysis have been documented in the literature. In general, this method is used to fit models for a dependent variable (e.g., a utilization index) as a function of one or more independent variables (such as facility area, occupancy, etc.). Regression analysis can simplify the modeling of unknown relationships between variables, but as more independent variables are used analysis becomes increasingly difficult and data acquisition costs rise substantially. Because a large number of independent variables would be required to fit a utilization index model, regression analysis was considered impractical and cost-prohibitive for this application. Therefore, the method was not investigated in depth.

Sources for Installation Space Utilization Data

The ideal basis for an installation space utilization index would be data gathered directly from the installations. As discussed under "Practicality Problems" in Chapter 4, it is unlikely that installations have personnel available to dedicate to data collection for a UI. The next-best basis for the UI would be complete, reliable data already collected and filed as part of some other reporting process. Two such potential data sources were evaluated: GSA Form 3530 and the *Installation Commander's Annual Real Property Utilization Survey* (ICARPUS) report.

Work Space Management Plan (GSA Form 3530)

GSA Form 3530 was a good candidate for data collection because all Army installations are required to use it. Using the data captured in Form 3530 would eliminate the need—and cost—to separately collect data for calculating the UI. Another advantage is that the data on Form 3530 are concise and comprehensive. USACERL contacted GSA, the central repository for all completed Form 3530s, and requested copies for analysis. However, GSA did not comply with the request. (Appendix B includes a sample Form 3530.)

The authors tested Form 3530 as a source for installation utilization data by creating simulated data consistent with the few copies of Form 3530 to which they had access. The simulated data were tested with the prototype methodology, and the results are published in Appendix B. Form 3530 proved to be very useful in assimilating large amounts of data, but the goal of developing a fair, accurate index cannot be met using

this form. Key advantages of Form 3530 become liabilities in the context of a utilization index. These and other problems are discussed in Chapter 4.

One disadvantage of using data from Form 3530 is that, due to the conciseness of the form, there is no room to make adjustments below the installation level (Figure B3). Without being able to make adjustments at least on the building level, the index cannot be considered fair and accurate. This inadequacy is evident when the method (using data from Form 3530) is evaluated against key applicability problems. Form 3530 data cannot even begin to address furniture- or building-related utilization issues. If, for example, an installation has many historic buildings, the data do not include enough detail for fair, accurate accounting for lower utilization rates that may justifiably occur in historic buildings. An index based on such data would report a lower utilization rate without taking the installation's special circumstances into account.

Another disadvantage is that data for key areas of Form 3530—those that deal with space utilization—are often not provided by many installations. This is often a result of manpower shortages. Furthermore, some installations appear to be unaware of Form 3530 or ignore the requirement to fill it out. This problem could be overcome by devoting more manpower to filling out and properly filing the form. However, this solution would undermine one of the main benefits of using the form in the first place—capturing existing data without devoting extra personnel to the job.

There is one other major problem with basing a UI on Form 3530 data. Although the submitted data for administrative facilities are comprehensive, the method used to gather those data may vary widely from installation to installation. Without a standard method for collecting data, comparing the data in a UI may be of little or no use. Some type of standard data collection and notation system would be needed before data could reliably be compared across installations and MACOMs.

Consequently, although it would be easy enough to use Form 3530 for a statistical study, as it was in the sample analysis reported in Appendix B, the results in most cases could not be assumed to be a fair or accurate assessment of relative utilization rates among installations nationwide.

The ICARPUS Report

The ICARPUS report was also evaluated as a possible source of data for an installation utilization index. The ICARPUS report has a potential advantage over Form 3530 as a data source because many submittals include data on land use. For any index addressing areas beyond utilization of administrative space, the ICARPUS could be

a valuable reference for utilization indexing purposes. However, using ICARPUS was determined to be unfeasible because its content and format is largely left to the discretion of the installation commander. Thus, the report varies widely in content and organization from one installation to another. Also, as is the case for Form 3530, many installations do not complete an ICARPUS every year.

4 Roadblocks to Implementing an Index

During development and testing of the prototype UI methodology, a number of roadblocks to implementation became apparent. These roadblocks appear to present significant problems for implementing any utilization index, regardless of the approach used. The problems fall into two main categories: (1) applicability to real-world installations and (2) practicality of the process. This chapter discusses these problems, as well as some other factors complicating the implementation of a UI.

Applicability Problems

The applicability problems are related to the question, "Can the utilization index be implemented in a fair and accurate manner?" Most of these problems will be inherent to any indexing system intended to compare facilities on a nationwide basis. Fairness and accuracy is difficult when comparing installations that have diverse missions—each has different space resources and requirements. Theoretically, the application of adjustment factors to subsets of the utilization data—or in some cases, to data for an entire installation—might compensate for some of the inequities inherent in the comparison of utilization among dissimilar installations (Figure 1).

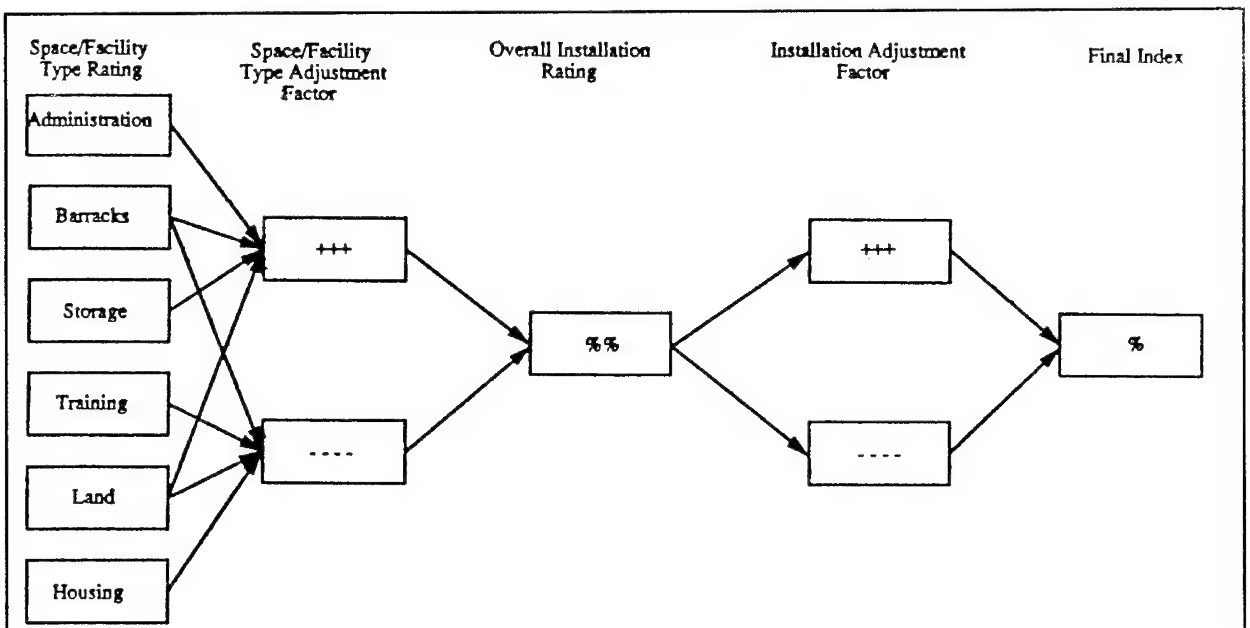

Figure 1. Adjustment factors.

Any successful indexing method must address the level of detail required to apply adjustments. That is, the method would have to identify at which level the data should be viewed—room level, building level, or installation level. However, the type, number, magnitude, description, and derivation of the adjustment factors must be considered. As the number of adjustments increases for a particular site, the index rating inherently becomes less objective, and may lose consistency across all sites indexed. Therefore, it was concluded that adjustment factors should be used in an indexing methodology only when absolutely necessary.

The amount of data available also affects the accuracy of the adjustments. In this study, data from only two installations were used to derive the adjustment factors. Data from many other installations and MACOMs would be required before the calculation of valid adjustment factors could even be attempted.

The following paragraphs discuss the major applicability problems identified in this research. The list may be incomplete, and space managers at both the installation and MACOM levels may be able to add to it.

Furniture-Related Problems

Two work areas, A and B, each house six workstations, and are equal in terms of square footage (Figure 2). This does not necessarily mean that each should have the same utilization rating, however. Density may not always show how much open space is available. This could cause problems if the workstations—especially due to their electronic requirements—are not easily relocatable (Figure 2). Many different types of modular furniture are used at various Army installations. Different types of modular furniture may significantly affect an installation's utilization rating, so an adjustment may be needed to compensate for the differences.

Building-Related Problems

Adjustment factors may be needed where space is undergoing extensive maintenance or remodeling. Without adjustment factors in such cases, temporary inefficiencies or

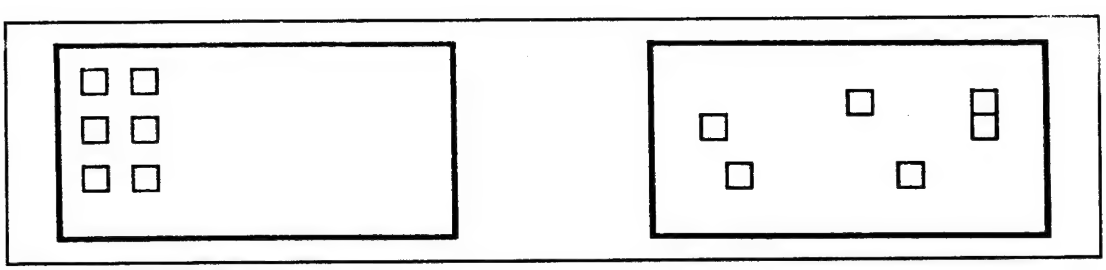

Figure 2. Work areas A and B.

underutilization could adversely affect an organization's utilization rating. Old buildings may also need adjustment factors. In this category of roadblocks, questions arise as to how age significantly affects utilization rates, and whether separate adjustments are required for different historical periods of origin (e.g., pre-1800, 1800–1880, 1880–1914, 1914–1939, and 1939–1950). Another problem is whether an old, converted building should automatically be categorized individually for utilization indexing purposes.

Adjustment factors also may be advisable when considering closed space versus open space, functional adequacy, and functional convenience. An unbiased utilization index should not reflect an inherent penalty for closed space (i.e., defined by fixed walls) simply because open space generally can be used more efficiently with reconfigurable modular or system furniture.

Questions of functional adequacy and convenience present different issues. In the example shown in Figure 3, Building 1 may be more *functionally adequate* for Group E's mission due to space configuration, internal facilities, etc. However, if Group E works closely with Groups C and D, then Building 2 may be more *functionally convenient* than Building 1. Group Z may be functionally unrelated to Groups C and D, but it may fit very well into Building 2 in terms of optimal space utilization. Adjustment factors also may be needed where there are obstacles such as heating, ventilating, and air conditioning (HVAC) equipment. The placement of floor grilles,

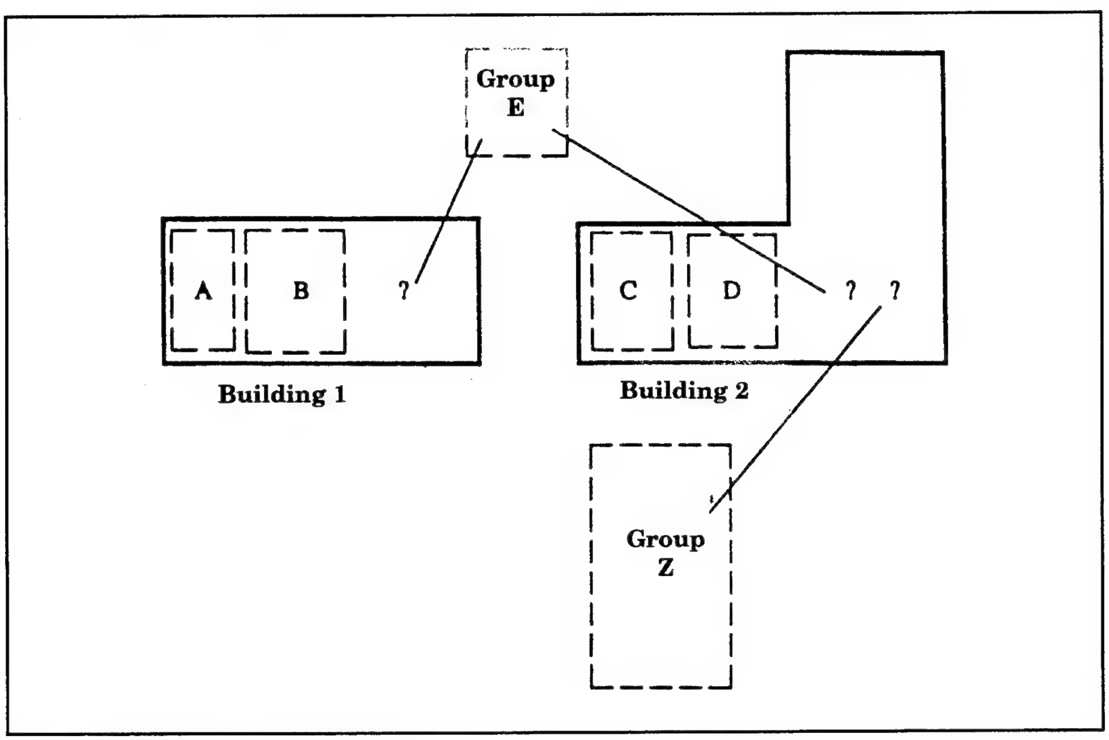

Figure 3. Building-related problems.

ducts, or electric baseboards, for example, may prevent facility managers from locating one or two workstations in an area that otherwise could be used.

Document-Related Problems

Code compliance may reduce the potential for high utilization. If codes vary from region to region, adjustments may be needed, but such adjustments would have to be considered arbitrary if not documented with a detailed statistical study. Department of Defense documents containing space utilization data could possibly be used to support a UI, but only if the data were complete, consistent, and readily available for all installations. As discussed in Chapter 3, complete data are not readily available for a variety of reasons.

Comparison Problems

Mobilization and base realignment also must be considered when evaluating facility utilization. Application of a UI adjustment factor may be necessary when an installation is underutilized because of realignment actions. An installation should not be penalized if the reason for underutilization is to prepare for arrival of new personnel.

Another relevant issue is whether it is feasible to compare utilization rates across MACOMs because of the diversity of MACOM missions and real property assets. Limited comparisons may be useful—in the category of administrative space, for example.

Practicality Problems

Practicality problems are related to the logistics of implementing the UI. Practicality issues include how often the UI should be updated, who will administer the process, who will collect and compile the date, etc. Although such questions may seem to be best dealt with after the indexing methodology is developed, these questions actually should be addressed during development of the methodology. Answers to these questions will directly affect the feasibility of any indexing methodology considered.

As noted previously, the UI is conceived ideally to be used across MACOMs. Developing effective adjustment factors to account for the different MACOM missions would require collection of a large amount of data from many different installations nationwide. But, as discussed earlier, the use of adjustment factors can compromise the objectivity of an installation's rating and, consequently, can undermine the consistency with which the methodology is applied from site to site.

Probably the largest factor affecting the practicality of implementing and using a UI would be the degree of support provided by installations. It seems clear that a high level of support by installation commands would be necessary to obtain the facility utilization data required for development of the base UI and appropriate adjustment values.

Other Complicating Factors

Calculating Adjustment Factors

It has been noted that many facility attributes discussed in this chapter (building age, wall placement, HVAC equipment placement, functional adequacy, etc.) would require adjustment factors to make the UI as unbiased as possible. It is clear that calculating the initial adjustment factors would require a very substantial database. During this study USACERL collected data from only four installations* (see Appendix C)—not enough installations to calculate valid adjustment factors. Any further development of an indexing method would have to include intensive data collection efforts.

Only after sufficient real-world data have been accumulated will it be possible to specify the method for determining valid adjustment factors. Adjustment factors must be calculated for all categories and subcategories of space. For example, there are five administrative components or subcategories: open office, private office, conference room, support space, and training room. Adjustments also must be calculated at the building level, and up to the installation level. If the level is lower or higher, it may be due to the special circumstances of a particular class (or classes) within the sample. For example, the average of the utilization index of historic buildings may fall below the index for the rest of the installation's facilities. This would have the effect of lowering the average for all buildings on the installation. Therefore, an appropriate adjustment factor might equal the quotient of the overall average and the historic building average. Such a factor would have the effect of smoothing the data by deemphasizing the effects of the least-typical cases. (See Figure 4.)

* Data from three of the four installations pertained to administrative space. Data from the other installation pertained to barracks. The tests reported in Appendix C used only the administrative space data.

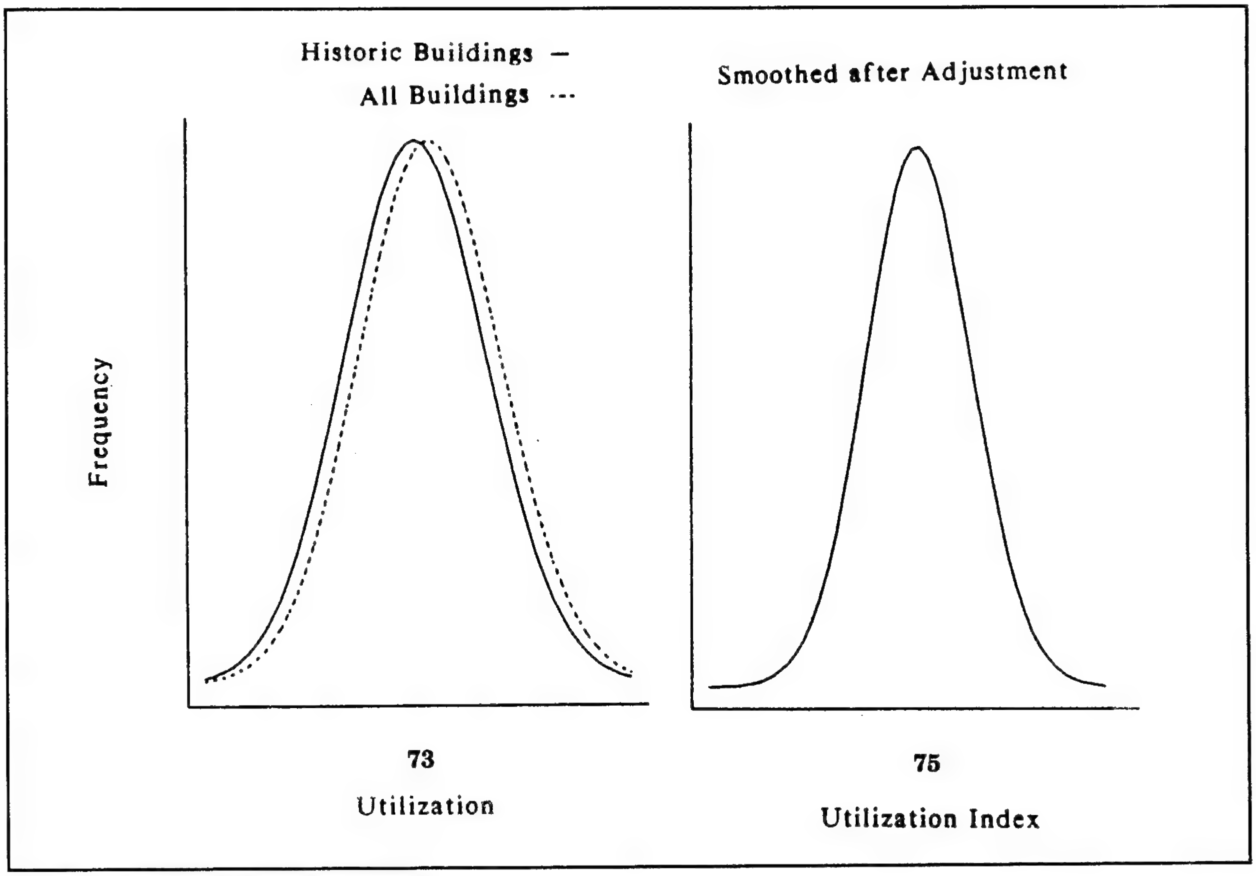

Figure 4. The effect of data smoothing.

Updating the Methodology

The indexing methodology may have to be updated at predetermined time intervals. The updating should reflect major policy changes, mission changes, and new building technology. Old adjustment factors may not necessarily apply far into the future. Mandatory reevaluation of the method should be built into the method itself. For example, the adjustment factors should be updated to reflect significant changes in the data. It is impossible to predict how often the data will change, or how significant the changes will be. Nevertheless, changes in mission, policy, and facilities must be expected and taken into consideration in development of the indexing methodology.

Adding Other Space Types

If a UI method is proven to be capable of equitably determining the relative utilization of administrative space, it is likely that there would be a demand for applying it to other space types. This would present a problem parallel to that of comparing installations with dissimilar missions and assets. The indexing methodology would have to

address the comparison of spaces as different as warehouses and barracks. It would have to be determined, for example, whether 50 percent utilization of warehouse space would affect an installation's overall rating differently than 50 percent utilization of barracks space?

Tools explored and lessons learned in developing an administrative UI could probably help adapt the indexing methodology to other types of space. However, development of additional indexing methodologies would be highly difficult, and the validity of the resulting product would probably be considered open to debate by any installation perceiving that it has special facility requirements.

5 Conclusions and Recommendations

Conclusions

The studies documented in this research were conducted toward the goal of developing a prototype installation space utilization index that could be used to measure the relative percentage of space utilization at various Army installations nationwide, across MACOMs. The current effort focused on utilization of administrative space, but issues related to expanding the UI to include other types of space also were considered.

Ideally, implementing a space utilization index method would require a minimum amount of additional work for installation space management personnel—mainly just a modest amount of labor hours to ensure data accuracy. However, based on discussions with personnel at various installations, the limited number of people who work in space management offices are already overburdened, and it would not generally be feasible to add new data collection and organizing tasks to their workload.

A number of applicability problems are inherent in the concept of a space utilization index for military installations. These include:

- furniture-related problems, such as the immobility of workstations
- building-related problems, such as utilization restrictions on historic facilities
- document-related problems, such as local building codes and availability of uniform DOD-wide data on space utilization
- facility comparison problems, such as 'calculated underutilization' on installations that must be ready to handle large personnel growth on very short notice.

A number of practicality problems also are inherent to the utilization index concept. These include:

- the diverse missions of installations, which may require different specifications for optimal utilization based on personnel density, equipment requirements, etc.
- the diverse space resources available from one installation to another.

Most of the above problems seem to call for the inclusion of adjustment factors—rules to compensate for site-specific or mission-specific biases inherent in an installation's

utilization statistics. While ideally it would be best to minimize the use of adjustment factors in any utilization indexing methodology, the very nature of comparing diverse facilities, installations, and MACOMs would seem to require the frequent use of adjustment factors on both small scales and large scales. The inclusion and assignment of adjustment factors would make the indexing methodology less than straightforward. However, the less straightforward the process—that is, the more adjustment factors used—the more open to challenge the indexing methodology would be.

Therefore, due to serious inherent problems both with applicability and practicality of implementing a UI, it is concluded that further work to develop a UI at this time would not produce useful results.

Recommendations

Despite the fact that it does not appear possible to develop a valid UI at this time, the objective of a UI—improvement of space utilization—must still be addressed if the Army is to make optimal use of its facilities. Lessons learned during this research and information gathered during the literature search suggest two possible alternatives the Army might pursue to improve the measurement and effectiveness of space utilization:

- an economics-based measurement
- benchmarking.

It is recommended that future efforts to quantify and improve Army-wide space utilization follow one of these two approaches—or perhaps a combination of the two.

An Economics-Based Approach

"Space utilization" is an abstract parameter. Even if the obstacles to indexing space utilization could be overcome, the index really would not provide any useful new input to master planners. On the other hand, cost, quality of life, and capability to support the Army mission are *concrete* indicators of utilization effectiveness—parameters that Army planners and budgeteers concern themselves with every day. It seems feasible, then, to view the *cost* of space per a given unit of measure as a surrogate indicator of space utilization effectiveness. An economics-based utilization indicator makes sense because it would give planners concrete information to act upon.

An economics-based approach for administrative space might be to develop an algorithm that calculates space costs per square foot per occupant. For example,

suppose that space planners on two installations—one in Georgia and the other in Michigan—are tasked to improve space utilization by consolidating administrative functions into fewer facilities. On both installations, administrative functions are housed in two building types—X and Y. Type X has fixed walls while Type Y has an open floor plan. Conventional wisdom might seem to dictate consolidating in the Type Y buildings because floor space could be used more efficiently than in the fixed-wall Type X structures. But using floor space with utmost efficiency may not be the best way to lower the installation's costs. Climate factors such as temperature or rainfall might escalate the utility or maintenance costs of Type Y buildings; the most space-effective solution may not be the least-cost solution for either installation. Using an economics-based approach for each option, planners would consider all cost factors as they pertain to the specific installation. The least-cost solution to improving space utilization in Georgia may be different than it is for Michigan.

The premise of an economics-based approach is that many factors—not just the number of people or items a building houses—affect how well space is being used. An economics-based approach would be tailored to each different category of space—warehouse utilization might be quantified in terms of cost per square foot per cubic foot, for example. The specific units of measure and cost inputs for each facility type would have to be developed in follow-on research.

Benchmarking

As discussed in Chapter 2, benchmarking may offer an alternative to indexing space utilization. A properly designed and executed benchmarking exercise could avoid the problems inherent in a UI while supporting its objective—the improvement of installation space utilization.

Under benchmarking, the installation would establish targets and practices based on data from recognized leaders in facility space management—both in industry and government. The continuous pursuit of these targets would lead to continuous improvement of installation space management. The end result would achieve the same thing as a UI, but the targets would be concrete and based on best practices rather than an abstract and debatable space utilization index.

The benchmarking approach may also be considered a more positive way to encourage more effective space utilization because it focuses on continuous improvement through cooperation and comparison of best practices among peers. This would avoid the competitive "report card" overtones that might develop with implementation of a utilization index.

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Appendix A: A Prototype Indexing Method Using RAM 1

This appendix describes a prototype space utilization index for administrative space on Army installations. The method is based on a USACERL-developed ratio analysis method called RAM 1.

Five subcategories of administrative space were identified: open office space, private office space, conference rooms, training rooms, and support space. Each subcategory has a "subutilization index," or "subindex." Due to problems described in Chapter 4, any number of these subindexes may require adjustment factors. One example of this would be a designated support space to which another workstation could be added without hindrance of the support function. Another example would be conference rooms used more during one time than another. To account for situations such as these, individual adjustment factors must be determined. Each subutilization index is multiplied by the appropriate adjustment factor (if necessary) to yield five adjusted subutilization indexes. (Appendix D includes a discussion of adjustment factors and how they were calculated).

To find the overall utilization index, these five subindexes must be aggregated. This is done by taking the weighted average of the adjusted subutilization indexes in terms of square footage. After calculating the overall utilization index, further adjustments may be necessary. For example, some older buildings do not have an open office plan, and that would have to be taken into consideration. Main adjustment factors for this type of scenario must be determined. The appropriate factor is determined, then the adjusted overall utilization index can be found by multiplying the overall utilization index by the main adjustment factor.

It should be noted that in cases where more than one adjustment factor applies to an index, all of the factors multiplied together determine the adjustment factor to be used for calculation.

Calculation of Index

Definition of Variables

The following variables used in the calculation of the utilization index are defined below:

O = open office subutilization index
P = private office subutilization index
C = conference room subutilization index
T = training room subutilization index
S = support space subutilization index
UTOT = overall subutilization index

AO = adjustment factor for open office
AP = adjustment factor for private office
AC = adjustment factor for conference room
AT = adjustment factor for training room
AS = adjustment factor for support space
AMAIN = main adjustment factor
O' = adjusted open office subutilization index
P' = adjusted private office subutilization index
C' = adjusted conference room subutilization index
T' = adjusted training room subutilization index
S' = adjusted support space subutilization index
UTOT' = adjusted overall utilization index

FO = open office square footage
FP = private office square footage
FC = conference room square footage
FT = training room square footage
FS = support space square footage
FTOT = total square footage

Algorithms

The algorithms for calculating subutilization and utilization indexes are included below:

Subutilization Indexes

O = [Authorized strength/Rated capacity] * 100

= [# workstations in open office/(FO/130)] * 100

P = [Authorized strength/Rated capacity] * 100

= [# workstations in private office/(FP/130)] * 100

C = [Hours in use/Total work hours] * 100

T = [Hours in use/Total work hours] * 100

S = 100

Adjusted Subutilization Indexes

O' = AO * O   C' = AC * C   S' = AS * S

P' = AP * P   T' = AT * T

Overall Utilization Index

UTOT = [0' * FO/FTOT] + [P' * FP/FTOT] + [C' * FC/FTOT] + [T' * FT/FTOT] + [S' * FS/FTOT]

Adjusted Overall Utilization Index

UTOT' = UTOT * AMAIN

Figure A1 illustrates how the administrative space utilization index is calculated.

Support space will be considered 100 percent utilized unless that space is large enough to accommodate at least one workstation without hindering in any way the support function or the workstation function.

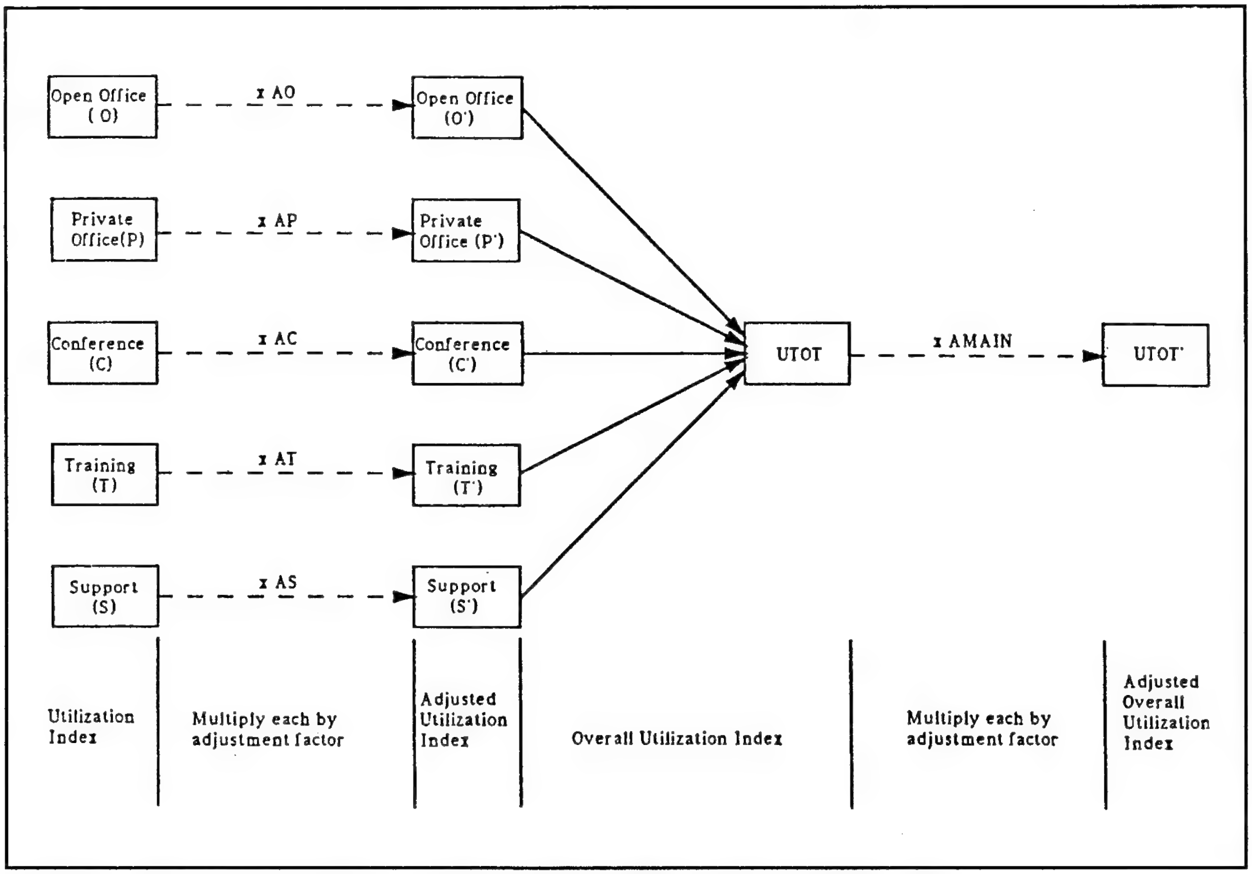

Figure A1. Illustration of process for calculating administrative space utilization index.

Appendix B: RAM 1 Analyses of Simulated Utilization Data

Statistical analysis of simulated data for administrative space utilization were performed using RAM 1, the method outlined in Appendix A. Two simulated data sources were used: (1) the USACERL-developed questionaire (Figure B1) and (2) GSA Form 3530.

In the first analysis, sample numbers were randomly entered into the UI questionnaires, and the appropriate indexes and square footage numbers for each building were computed using a spreadsheet. For example, Table B1 shows the spreadsheet results for Bldg A6540 at Installation GREEN. After these characteristics for each building were calculated, they were combined on the weight basis of square footage to achieve a total utilization index for the entire installation.

Tables B2 through B6 display the results of this analysis for five different sample installations. The distribution of the utilization indexes for buildings is provided in Figure B2.

Fill out a separate data form for each administration building

- If more data forms are needed just make photo copies of these.
- It is not necessary to fill out a form for all administration buildings; however, please do as many as possible.

Building:__________ Building age:__________

	Square Feet	# workers in space	% working day in use	# stations could fit
Open office space				X
Private office space				X
Conference rooms				X
Support space				
Training rooms				

Figure B1. Utilization questionnaire for administration buildings.

Table B1. Sample Space Utilization Data for Bldg A6540 at Installation GREEN.

	Open Office	Private Office	Conference Room	Support Space	Training Room
Square Feet	4,520	1,000	780	1,050	0
No. of Workstations	31	3			
Hours in Use			20		
Work Hours Available			80		
Subutilization Index	89.16	39.00	25.00	100.00	N/A
Adjustment Factor	1.00	0.75	1.00	1.00	N/A
Adjusted Subutilization Index (ASI)	89.16	29.25	25.00	100.00	N/A
Weight (ASI x Square Feet)	403,003	29,250	19,500	105,000	N/A
Total Building Square Feet	7,350				
Overall Utilization Index	75.75				
Main Adjustment Factor	1.00				
Adjusted, Overall Utilization Index	75.75				

Table B2. Sample Installation: ORANGE.

Building	Age	Square feet	Index	Weight
BS80	45	6,245	0.604	3,771.98
BS85	45	3,585	0.635	2,276.475
BS191	10	21,780	1.012	22,041.36
BS192	15	19,558	0.846	16,546.06
BS291	5	13,600	0.78	10,608
BS292	5	13,595	0.673	9,149.435
BSA15	45	4,125	0.368	1,518
BSA16	45	4,360	0.637	2,777.32
BS293	5	3,580	0.833	2,982.14
BS294	5	3,470	0.36	1,249.2
BS490	5	3,280	0.744	2,440.32
BS390	5	5,340	0.948	5,062.32
BS1	175	4,365	0.379	1,654.335
BS2	180	3,030	0.414	1,254.42
TOTALS		109,913	0.758157	83,331.27

Installation Utilization Index =75.81575
UI = Total Weight ÷ Total Square Feet

Table B3. Sample Installation: YELLOW.

Building	Age	Square Feet	Index	Weight
15A	5	2,550	0.723	1,843.65
17A	45	2,950	0.881	2,598.95
A754	20	23,195	0.842	19,530.19
A807	15	45,345	0.767	34,779.61
A873	10	16,025	0.774	12,403.35
A874	20	6,070	0.68	4,127.6
A900	20	14,130	0.864	12,208.32
A805	15	16,810	0.572	9,615.32
A533	15	8,470	0.844	7,148.68
A537	80	3,100	0.695	2,154.5
A507	45	2,800	0.511	1,430.8
A515	45	3,110	0.706	2,195.66
A484	45	5,425	0.6	3,255
A485	40	5,730	0.6732	3,857.436
A455	45	4,820	0.69	3,325.8
TOTALS		165,980	0.745343	123,712.1

Installation Utilization Index = 74.53438
UI = Total Weight ÷ Total Square Feet

Table B4. Sample Installation: BLUE.

Building	Age	Square Feet	Index	Weight
1001	45	2,525	0.625	1,578.125
1010	25	13,670	0.648	8,858.16
244	45	4,175	0.634	2,646.95
347	15	4,880	0.593	2,893.84
137	10	8,440	0.297	2,506.68
139	40	3,700	0.594	2,197.8
U2	10	13,485	0.667	8,994.495
B1	5	14,590	0.705	10,285.95
B2	1	10,547	0.541	5,705.927
M16	35	7,962	0.698	5,557.476
135	10	5,400	1.0	5,400
136	10	3,500	0.846	2,961
DOOBEE	20	11,332	0.71	8,045.72
TOTALS		115,206	0.631261	72,725.12

Installation Utilization Index = 63.12615
UI = Total Weight ÷ Total Square Feet

Table B5. Sample Installation: GREEN.

Building	Age	Square Feet	Index	Weight
A1550	25	192,770	0.821	158,264.1
A1670	10	8,262	0.569	4,701.078
A6540	45	7,350	0.757	5,563.95
A6550	45	6,855	0.928	6,361.44
A6520	45	7,095	0.929	6,591.255
A6530	45	8,760	0.815	7,139.4
A8530	20	7,060	0.813	5,739.78
A8540	20	8,600	0.687	5,908.2
A8510	20	6,830	0.732	4,999.56
A8520	20	7,525	0.911	6,855.275
A8550	20	9,955	0.734	7,306.97
A8560	20	3,300	0.777	2,564.1
TOTALS		274,362	0.809132	221,995.1

Installation Utilization Index = 80.91323
UI = Total Weight ÷ Total Square Feet

Table B6. Sample Installation: PURPLE.

Building	Age	Square Feet	Index	Weight
66A	18	7,000	0.435	3,045
67A	30	5,400	0.676	3,650.4
144A	1	138,150	0.693	95,737.95
200A	10	37,680	0.915	34,477.2
75M	20	15,205	0.681	10,354.60
22X	15	38,675	0.805	31,133.37
59A	10	20,425	0.82	16,748.5
37B	47	4,885	0.743	3,629.555
FL155	15	10,251	0.836	8,569.836
FL160	15	12,036	0.861	10,362.99
FL165	15	9,895	0.578	5,719.31
FL170	15	4,707	0.713	3,356.091
FL175	15	6,400	0.659	4,217.6
FL180	15	5,505	0.787	4,332.435
FL185	15	6,565	0.763	5,009.095
FL190	15	11,910	0.624	7,431.84
43T	20	4,350	0.599	2,605.65
45T	15	12,005	0.824	9,892.12
20A	150	3,275	0.594	1,945.35
57A	5	59,300	0.556	32,970.8
65A	40	3,497	0.775	2,710.175
71A	15	3,105	0.743	2,307.015
Totals		420,221	0.714402	300,206.8

Installation Utilization Index = 71.44024
UI = Total Weight ÷ Total Square Feet

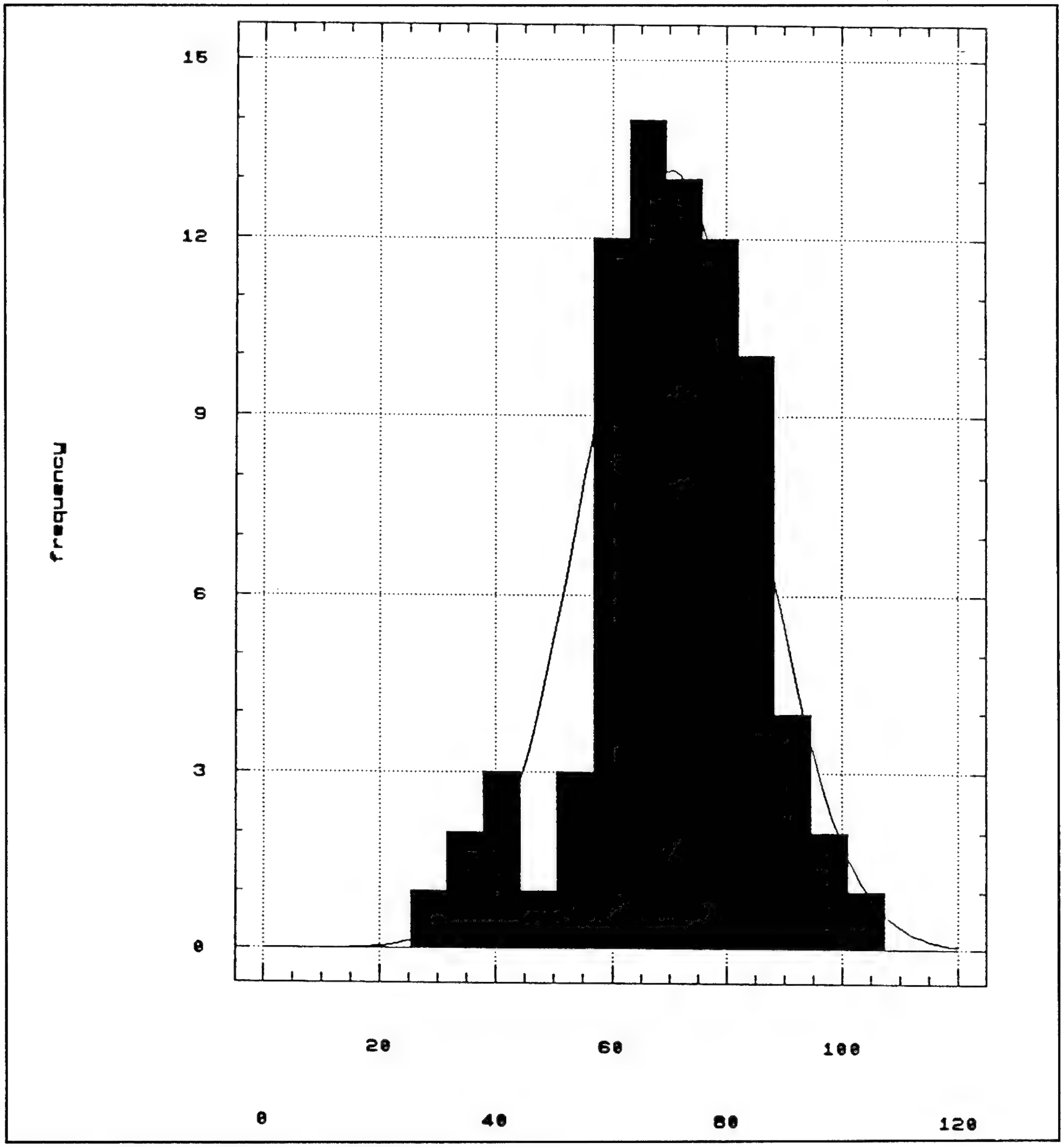

Figure B2. Frequency histogram for all buildings in sample.

As noted above, the other sample analysis was performed using simulated data entered into the GSA Form 3530, *Work Space Management Plan and Budget Justification.* Once again, sample forms were filled in the same manner that the actual forms are completed. However, this analysis varied in that the given data are the square footage per worker. These had to be converted to indexes on the basis of 135 sq ft equals 100 percent utilization per worker. As noted in the text, significant flexibility and accuracy is lost with this method. The sample Form 3530 is reproduced

in Figure B3. The calculated indexes for each installation and budget year are shown in Table B7, and the frequency distribution of the installation utilization indexes are shown in Figures B4 through B6.

Please note that the results displayed in these two sample studies are for demonstration of the different methods only. The actual data in terms of the utilization indexes, their averages, and related distributions, may be entirely different from the results encountered here. Appendix C discusses a pilot run of the methodology on real-world data from several installations.

WORK SPACE MANAGEMENT PLAN AND BUDGET JUSTIFICATION

INTERAGENCY REPORT CONTROL NO. 0323 GSA XX

AGENCY

ACCOUNT TITLE

BUREAU

ACCOUNT ID CODE

SECTION I – WORK SPACE MANAGEMENT PLAN

				PRIOR YEAR 19__	CURRENT YEAR 19__	BUDGET YEAR 19__
A. OFFICE UTILIZATION RATE ESTIMATES (NOTE. Only agencies that classify their rented or owned office space according to actual use rather than predominant use will be able to complete items 2, 3, and 4.	1. GSA CONTROLLED SPACE		AVERAGE OFFICE UTILIZATION RATE			
			SUPPLEMENTAL SPACE FACTOR			
			ADJUSTED OFFICE UTILIZATION RATE			
	2. AGENCY-RENTED SPACE		AVERAGE OFFICE UTILIZATION RATE			
			SUPPLEMENTAL SPACE FACTOR			
			ADJUSTED OFFICE UTILIZATION RATE			
	3. AGENCY-OWNED SPACE		AVERAGE OFFICE UTILIZATION RATE			
			SUPPLEMENTAL SPACE FACTOR			
			ADJUSTED OFFICE UTILIZATION RATE			
	4. TOTAL SPACE		AVERAGE OFFICE UTILIZATION RATE			
			SUPPLEMENTAL SPACE FACTOR			
			ADJUSTED OFFICE UTILIZATION RATE			
	5. FY UTILIZATION RATE OF 135 WILL BE ACHIEVED					
	GSA CONTROLLED SPACE		AGENCY-CONTROLLED SPACE			
B. PERSONNEL AND WORK STATION ESTIMATES (Applies only to space reported on this form.) NOTE: Only agencies that classify their rented or owned office space according to actual use rather than predominant use will be able to complete items 3b, 3c, and 3d.	1. TOTAL AGENCY FTE					
	2. PERSONNEL	a. GSA CONTROLLED SPACE	PERMANENT			
			PEAK PT AND CYCLICAL			
			NON-AGENCY			
			TOTAL GSA SPACE			
		b. AGENCY-RENTED SPACE	PERMANENT			
			PEAK PT AND CYCLICAL			
			NON-AGENCY			
			TOTAL AGENCY-RENTED SP.			
		c. AGENCY-OWNED SPACE	PERMANENT			
			PEAK PT AND CYCLICAL			
			NON-AGENCY			
			TOTAL AGENCY-OWNED SP.			
	3. WORK-STATIONS	a. GSA-CONTROLLED SPACE				
		b. AGENCY-RENTED SPACE				
		c. AGENCY-OWNED SPACE				
		d. TOTAL WORKSTATIONS				
C. WORK SPACE ESTIMATES (SQ. FT. 000) (Use end of year estimates, except where noted.) NOTE: Item 2 must include all space obtained from non-Federal sources, whether or not the agency pays for it. Items 2, 3, and 4: Agencies that classify their rented or owned space according to actual use must report all categories. Agencies that classify their rented or owned space by predominant use should convert their total gross or net space to occupiable as prescribed in Sect. 101-17.003(d) of FPMR Temp. Reg. D-73.	1. GSA CONTROLLED SPACE	a. MARCH 15, PY BASE (Agency estimates)	OFFICE SPACE			
			NON-OFFICE SPACE (Ex. park.)			
			PARKING-INSIDE			
			PARKING-OUTSIDE			
			TOTAL			
		b. REQUIRED	OFFICE SPACE			
			NON-OFFICE SPACE (Ex. park.)			
			PARKING-INSIDE			
			PARKING-OUTSIDE			
			TOTAL			
	2. AGENCY-RENTED SPACE		OFFICE SPACE			
			NON-OFFICE SPACE (Ex. park.)			
			PARKING			
			TOTAL			
	3. AGENCY-OWNED SPACE		OFFICE SPACE			
			TOTAL			
	4. TOTAL SPACE NOTE: This total is the sum of 1b, 2, and 3.		OFFICE SPACE			
			PARKING (1b and 2 only)			
			TOTAL			

NAME AND TITLE OF PREPARER | TELEPHONE NO. | DATE

GENERAL SERVICES ADMINISTRATION

GSA FORM 3530 (REV. 1-87)

Figure B3. Sample GSA Form 3530.

Table B7. Utilization Index calculation using GSA Form 3530.

Prior Year 1988		Current Year 1989		Budget Year 1990	
Sq ft	Index	Sq ft	Index	Sq ft	Index
160	84.375	150	90	145	93.10344
175	77.14285	165	81.81818	145	93.10344
175	77.14285	163	82.82208	149	90.60402
125	108	130	103.8461	135	100
120	112.5	115	117.3913	125	108
165	81.81818	160	84.375	159	84.90677
205	65.85365	193	69.94818	164	82.31707
175	77.14285	135	100	140	96.42857
165	81.81818	185	72.97297	145	93.10344
135	100	135	100	135	100
137	98.54014	177	76.27118	135	100
167	80.8382	175	77.14285	153	88.23529
163	82.82208	175	77.14285	148	91.21621
163	82.82208	159	84.90566	155	87.09677
173	78.03468	163	82.82208	149	90.60402
201	67.16417	163	82.82208	154	87.66233
201	67.16417	153	82.23529	174	77.58620
161	83.85093	173	78.03468	139	97.12230
162	83.33333	143	94.40559	141	95.74468
175	77.14285	195	69.23076	165	81.81818
135	100	165	81.81818	155	87.09677
135	100	155	87.09677	195	69.23076
145	93.10344	150	90	150	90
180	75	155	87.09677	145	93.10344
150	90	150	90	145	93.10344
145	93.10344	125	108	135	100
165	81.81818	170	79.41176	145	93.10344
195	69.2307	190	71.05263	185	72.97297
200	67.5	200	67.5	185	72.97297
156	81.81818	155	87.09677	160	84.375
145	93.10344	155	87.09677	140	96.42857
125	108	130	103.8461	135	100
190	71.05263	185	72.97297	170	79.41176
175	77.14285	165	81.81818	165	81.81818
155	87.09677	135	100	135	100
160	84.375	165	81.81818	155	87.09677
155	87.09677	145	93.10433	140	96.42857
130	103.8461	135	100	135	100
150	90	145	93.10344	142	95.07042
145	93.10344	143	94.40559	135	100
Mean	85.35		86.64		90.77
Std Deviation	12.01		11.42		8.71

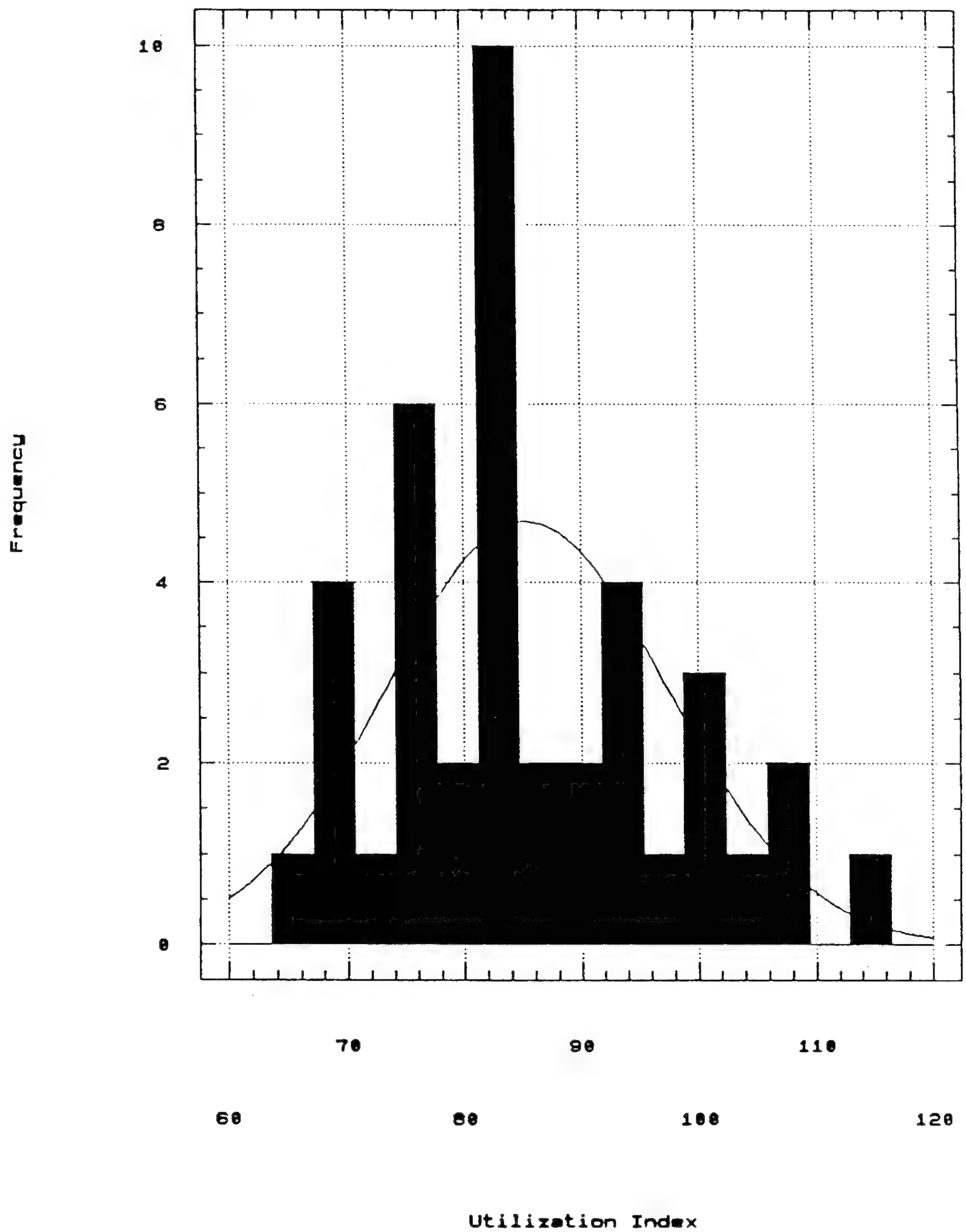

Figure B4. Frequency histogram for 1988.

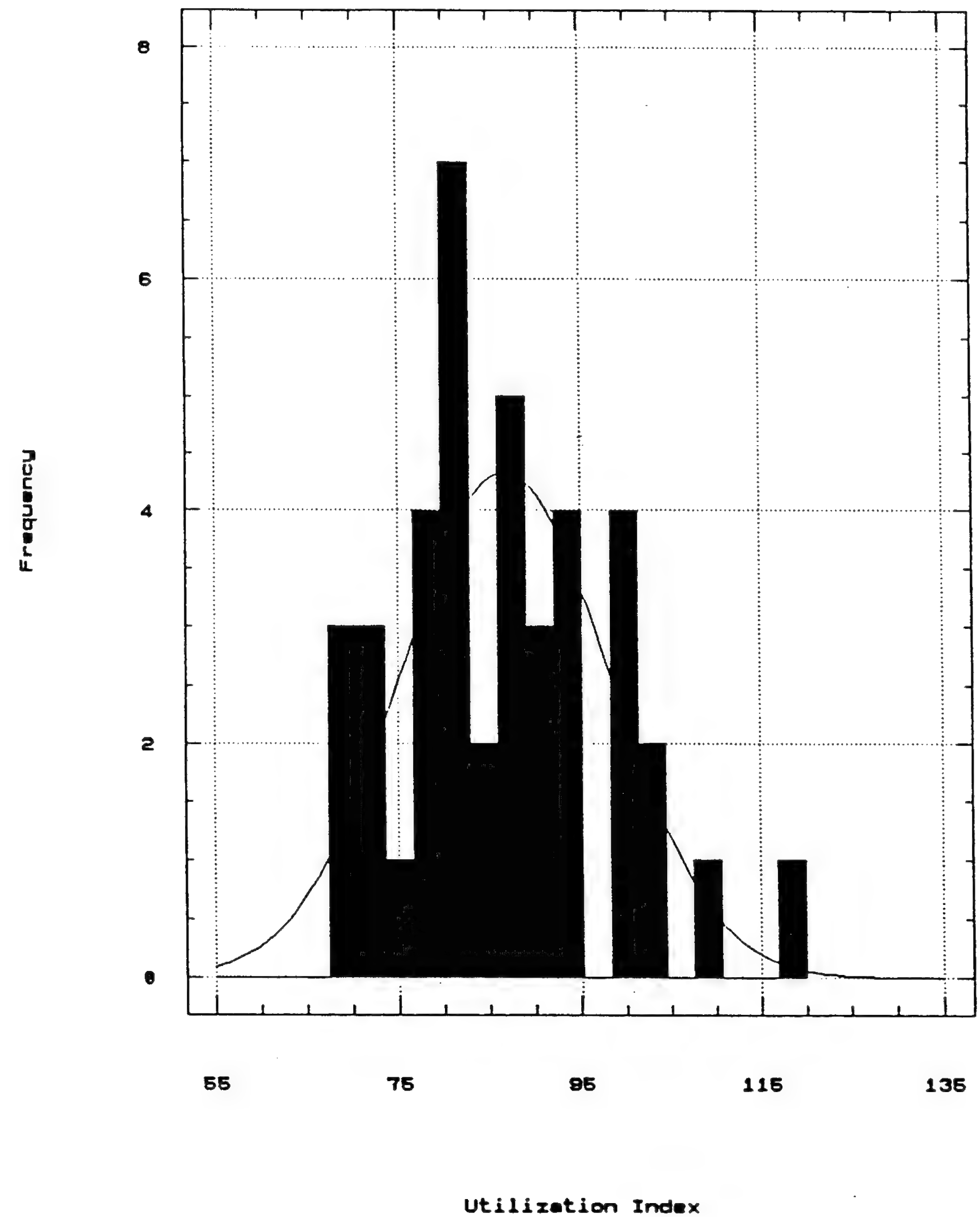

Figure B5. Frequency histogram for 1989.

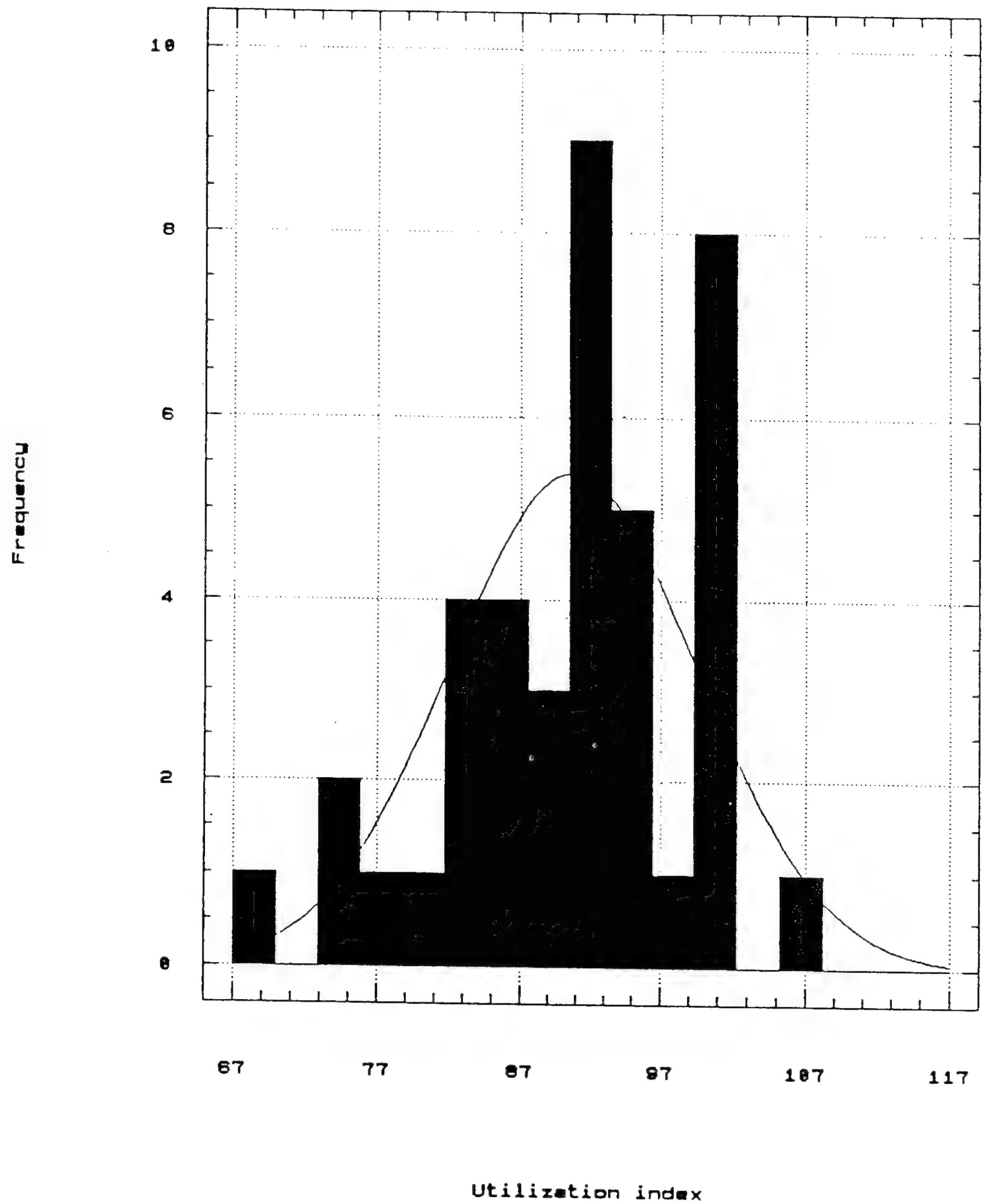

Figure B6. Frequency histogram for FY90.

Appendix C: Analysis of Real Data

This appendix describes the utilization indexes for administrative space at three Army installations.

USACERL Administrative Space

A study was performed for the three main buildings at USACERL, known locally as Building 1, Building 2, and the Zackrison Building. The method used to calculate each building utilization index and the total utilization index was the same as described in Appendix A and demonstrated in Appendix B. The results are presented in Tables C1 through C4.

Fort Eustis and Fort Story Administrative Space

Local space management reports were acquired from two Army installations, Fort Eustis and Fort Story. Both reports, entitled *Utilization of Administrative Space*, were dated 10 November 1988. Utilization indexes were calculated for each building of each installation in a manner similar to the Form 3530 method described in Appendix B, with 130 sq ft equaling 100 percent utilization. Note that both installations exceeded 100 percent overall utilization; this is a good example of why adjustment factors are necessary. The first pages of the data reports from Fort Eustis and Fort Story are included in columns (a) – (n) of Tables C5 and C6, respectively. The resulting indexes for each building at each installation, and the final aggregated index for each installation, are shown in columns (o) – (r) of Tables C5 and C6.

Table C1. Sample space utilization data for USACERL Zackrison Building.

	Open Office	Private Office	Conference Room	Support Space	Training Room
Square Feet	21,426	0	3,970	1,144	0
No. of Workstations	136				
Hours in Use			180		
Work Hours Available			288		
Subutilization Index	82.52		62.5	100	
Adjustment Factor	1	N/A	1.16	1	N/A
Adjusted Subutilization Index (ASI)	82.52	N/A	72.5	100	
Weight (ASI x Square Feet)	1,768,000	N/A	287,825	114,400	
Total Building Square Feet	26,540				
Overall Utilization Index	81.77				
Main Adjustment Factor	1.00				
Adjusted, Overall Utilization Index	81.77				

Table C2. Sample space utilization data for USACERL Building 2.

	Open Office	Private Office	Conference Room	Support Space	Training Room
Square Feet	0	34,704	639	12,657	0
No. of Workstations		166			
Hours in Use			145		
Work Hours Available			160		
Subutilization Index	N/A	62.18	90.63	100	N/A
Adjustment Factor	N/A	1.00	1.00	1.00	N/A
Adjusted Subutilization Index (ASI)	N/A	0.6218	0.9063	100	N/A
Weight (ASI x Square Feet)	N/A	2,158,000	57,909	1,265,700	N/A
Total Building Square Feet	48,000				
Overall Utilization Index	72.53				
Main Adjustment Factor	1.10				
Adjusted, Overall Utilization Index	79.79				

Table C3. Sample space utilization data for USACERL Building 1.

	Open Office	Private Office	Conference Room	Support Space	Training Room
Square Feet	0	18,246	2,408	29,746	0
No. of Workstations		96			
Hours in Use			134		
Work Hours Available			160		
Subutilization Index	N/A	68.40	83.75	100	N/A
Adjustment Factor	N/A	1.00	1.00	1.00	N/A
Adjusted Subutilization Index (ASI)	N/A	68.40	83.75	100	N/A
Weight (ASI x Square Feet)	N/A	1,248,000	201,670	2,974,600	N/A
Total Building Square Feet	50400				
Overall Utilization Index	87.78				
Main Adjustment Factor	1.10				
Adjusted, Overall Utilization Index	96.56				

Table C4. USACERL Installation Utilization Index.

Building	Age	Square Feet	Adjusted, Overall Utilization Index (UTOT')	Weight (UTOT' x Square Feet)
1	20	50,400	0.965614	48,666.95
2	20	48,000	0.797868	38,297.66
Zackrison	20	26,540	0.817718	21,702.24
Totals		124,940		108,666.85
Installation Utilization Index = 86.9752				

Table C5. Utilization of administrative space for Fort Eustis.

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
Bldg. No.	Gross Admin Space (sq. ft.)	Aisle & Struct. Loss (sq. ft.)	Conf. Room Space (sq. ft.)	Special Use Space (sq. ft.)	Storage Use Space (sq. ft.)	Net Office Space (sq. ft.)	Actual Admin Persn.	Auth. Admin Persn.	Auth. Other Persn.	Total Auth. Persn.	Space / Actual Admin Persn. (sq. ft.)	Space / Total Auth. Persn. (sq. ft.)	Cat. 610xx?	Actual Office Subutil. Index	Actual Weight	Auth. Office Subutil. Index	Auth. Weight
811	3,428					3,428	19	25		25	180.42	137.12	N	0.7205	2,470	0.9481	3,250
851	4,040					4,040	26	32		32	155.38	126.25	N	0.8366	3,380	1.0297	4,160
863	3,775					3,775	21	28		28	179.76	134.82	N	0.7232	2,730	0.9642	3,640
312	2,758	117		1,701		940	9	12	1	13	104.44	72.31	Y	1.2447	1,170	1.7979	1,690
309	803					803	7	7	15	22	114.71	36.50	N	1.1333	910	3.5616	2,860
727	4,882	412	236	787	717	2,730	8	8		8	341.25	341.25	Y	0.3810	1,040	0.3810	1,040
766	196					196	2	2		2	98.00	98.00	Y	1.3265	260	1.3265	260
768	144					144	2	2		2	72.00	72.00	Y	1.8056	260	1.8056	260
770	144					144	2	2		2	72.00	72.00	Y	1.8056	260	1.8056	260
591	2,487					2,487	6	6		6	414.50	414.50	Y	0.3136	780	0.3136	780
504	1,512					1,512	3	3		3	504.00	504.00	Y	0.2579	390	0.2579	390
513	2,210					2,210	2	2		2	1,105.00	1,105.00	Y	0.1176	260	0.1176	260
522	2,444					2,444	5	5		5	488.80	488.80	Y	0.2660	650	0.2660	650
1080	6,248					6,248	8	8		8	781.00	781.00	Y	0.1665	1,040	0.1665	1,040
1053	560					560	6	6		6	93.33	93.33	N	1.3929	780	1.3929	780
1062	1,500	400				1,100	4	4		4	275.00	275.00	N	0.4727	520	0.4727	520
1075	2,268	320				1,948	25	25		25	77.92	77.92	N	1.6684	3,250	1.6684	3,250
1078	1,803					1,803	41	58		58	43.98	31.09	N	2.9562	5,330	4.1819	7,540
523	2,368					2,368	4	4		4	592.00	592.00	Y	0.2196	520	0.2196	520
300	11,512	1,439	322	593	105	9,053	25	29	3	32	362.12	282.91	Y	0.3590	3,250	0.4595	4,160
563	1,716					1,716	2	2		2	858.00	858.00	Y	0.1515	260	0.1515	260
1072	604					604	5	7		7	120.80	86.29	N	1.0762	650	1.5066	910
1077	601					601	7	7		7	85.86	85.86	N	1.5141	910	1.5141	910
514B	815					815	1	0		0	815.00		Y	0.1595	130	0.0000	0
704	2,258	308	242	520	219	969	9	9	6	15	107.67	64.60	Y	1.2074	1,170	2.0124	1,950
808	708					708	3	2	1	3	236.00	236.00	N	0.5508	390	0.5508	390
1015	1,196	200			70	926	12	12		12	77.17	77.17	N	1.6847	1,560	1.6847	1,560
1019	4,800	1,318	200		1,550	1,732	89	89		89	19.46	19.46	N	6.6801	11,570	6.6801	11,570
1025	1,476					1,476	30	25		25	49.20	59.04	N	2.6423	3,900	2.2019	3,250
1030	3,186					3,186	53	53		53	60.11	60.11	N	2.1626	6,890	2.1626	6,890
1034	820					820	10	10		10	82.00	82.00	N	1.5854	1,300	1.5854	1,300
1035	824					824	43	34	5	39	19.16	21.13	N	6.7840	5,590	6.1529	5,070
1044	4,400					4,400	35	35	5	40	125.71	110.00	N	1.0341	4,550	1.1818	5,200
TOTALS	78,486	4,514	1,000	3,601	2,661	66,710	524	553	36	589	127.31	113.26			68,120		76,570
														Actual		Auth.	
											Installation Utilization Indexes =			102.11		114.78	

Table C6. Utilization of administrative space for Fort Story.

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
Bldg. No.	Gross Admin Space (sq. ft.)	Aisle & Struct. Loss (sq. ft.)	Conf. Room Space (sq. ft.)	Special Use Space (sq. ft.)	Storage Use Space (sq. ft.)	Net Office Space (sq. ft.)	Actual Admin Persn.	Auth. Admin Persn.	Auth. Other Persn.	Total Auth. Persn.	Space / Actual Admin Persn. (sq. ft.)	Space / Total Auth. Persn. (sq. ft.)	Cat. 610xx?	Actual Office Subutil. Index	Actual Weight	Auth. Office Subutil. Index	Auth. Weight
812	1,174					1,174	8	4	4	8	146.75	146.75	N	0.8859	1,040	0.8859	1,040
1569	3,377					3,377	25	17	8	25	135.08	135.08	N	0.9624	3,250	0.9624	3,250
2756	1,186					1,186	11	11		11	107.82	107.82	N	1.2057	1,430	1.2057	1,430
1004	2,155					2,155	15	15		15	143.67	143.67	N	0.9049	1,950	0.9049	1,950
1013	3,444					3,444	30	21		21	114.80	164.00	N	1.1324	3,900	0.7927	2,730
1563	2,971		775	30	200	1,966	6	6	6	12	327.67	163.83	Y	0.3967	780	0.7935	1,560
2797	1,895					1,895	12	12		12	157.92	157.92	N	0.8232	1,560	0.8232	1,560
661	3,797					3,797	6	19		19	632.83	199.84	N	0.2054	780	0.6505	2,470
417	1,309	284		317		708	15	15		15	47.20	47.20	Y	2.7542	1,950	2.7542	1,950
823	1,468					1,468	17	17		17	86.35	86.35	N	1.5055	2,210	1.5055	2,210
825	4,968					4,968	58	58		58	85.66	85.66	N	1.5177	7,540	1.5177	7,540
826	594					594	10	10		10	59.40	59.40	N	2.1886	1,300	2.1886	1,300
829	2,465					2,465	25	25		25	98.60	98.60	N	1.3185	3,250	1.3185	3,250
830	2,375					2,375	32	32		32	74.22	74.22	N	1.7516	4,160	1.7516	4,160
831	1,833					1,833	16	16		16	114.56	114.56	N	1.1348	2,080	1.1348	2,080
835	1,472	168		128	117	1,059	9	9		9	117.67	117.67	Y	1.1048	1,170	1.1048	1,170
836	1,344					1,344	12	12		12	112.00	112.00	N	1.1607	1,560	1.1607	1,560
861	29,201	1,590	45	852	19,985	6,729	64	64		64	105.14	105.14	Y	1.2364	8,320	1.2364	8,320
1511	2,740	1,572		820	192	156	4	4		4	39.00	39.00	Y	3.3333	520	3.3333	520
1005	765					765	10	6		6	76.50	127.50	N	1.6993	1,300	1.0196	780
1012	5,876					5,876	23	23		23	255.48	255.48	N	0.5089	2,990	0.5089	2,990
401	55,003	15,437	1,640	6,556	749	30,621	207	225	47	272	147.93	112.58	Y	0.8788	26,910	1.1548	35,360
403	4,110	895	72	2,781		362	20	15	5	20	18.10	18.10	Y	7.1823	2,600	7.1823	2,600
404	3,058					3,058				0	N/A	N/A	Y	0.0000	0	0.0000	0
409	3,503					3,503	26	28	8	36	134.73	97.31	N	0.9649	3,380	1.3360	4,680
1561	4,720					4,720				0	N/A	N/A	Y	0.0000	0	0.0000	0
1568	4,720					4,720				0	N/A	N/A	Y	0.0000	0	0.0000	0
210	1,050					1,050	7	7		7	150.00	150.00	Y	0.8667	910	0.8667	910
601	22,172	134		20,280		1,758	12	12		12	146.50	146.50	Y	0.8874	1,560	0.8874	1,560
661	16,152	1,632				14,520	128	120		120	113.44	121.00	N	1.1460	16,640	1.0744	15,600
1705	1,296	176	749			371				0	N/A	N/A	Y	0.0000	0	0.0000	0
1714	3,663	799		503		2,361	14	13	3	16	168.64	147.56	Y	0.7709	1,820	0.8810	2,080
1514	4,720	1,917		582	201	2,020	11	23		23	183.64	87.83	Y	0.7079	1,430	1.4802	2,990
1522	4,720	1,012		2,067	352	1,289	6	6		6	214.83	214.83	Y	0.6051	780	0.6051	780
1523	4,720	1,278	420	404		2,618	16	16		16	163.63	163.63	Y	0.7945	2,080	0.7945	2,080
1528	4,720	1,276		121	149	3,174	23	23		23	138.00	138.00	Y	0.9420	2,990	0.9420	2,990

(a) Bldg. No.	(b) Gross Admin Space (sq. ft.)	(c) Aisle & Struct. Loss (sq. ft.)	(d) Conf. Room Space (sq. ft.)	(e) Special Use Space (sq. ft.)	(f) Storage Use Space (sq. ft.)	(g) Net Office Space (sq. ft.)	(h) Actual Admin Persn.	(i) Auth. Admin Persn.	(j) Auth. Other Persn.	(k) Total Auth. Persn.	(l) Space / Actual Admin Persn. (sq. ft.)	(m) Space / Total Auth. Persn. (sq. ft.)	(n) Cat. 610xx?	(o) Actual Office Subutil. Index	(p) Actual Weight	(q) Auth. Office Subutil. Index	(r) Auth. Weight
1529	4,720	1,121	216	707	24	2,652	12	12		12	221.00	221.00	Y	0.5882	1,560	0.5882	1,560
1534	4,720	1,557	140	974		2,049	14	12	2	14	146.36	146.36	Y	0.8882	1,820	0.8882	1,820
1542	4,720	1,617	150	656	52	2,245	21	15	6	21	106.90	106.90	Y	1.2160	2,730	1.2160	2,730
1549	4,720	1,124	132	2,074	220	1,170	15	9	6	15	78.00	78.00	Y	1.6667	1,950	1.6667	1,950
1557	4,720	1,373	150	1,126	170	1,901	17	17		17	111.82	111.82	Y	1.1625	2,210	1.1625	2,210
1707	4,720	1,536	324	264	99	2,497	20	21	1	22	124.85	113.50	Y	1.0412	2,600	1.1454	2,860
1717	4,720	1,633		735		2,352	19	10	11	21	123.79	112.00	Y	1.0502	2,470	1.1607	2,730
1719	4,720	867		1,050	57	2,746	23	25		25	119.39	109.84	Y	1.0889	2,990	1.1835	3,250
1720	1,984	40		1,468	338	138	1	1		1	138.00	138.00	Y	0.9420	130	0.9420	130
1721	4,720	1,227		932	112	2,449	19	19		19	128.89	128.89	Y	1.0086	2,470	1.0086	2,470
1725	4,720	1,486	126	749	50	2,309	22	24	3	27	104.95	85.52	Y	1.2386	2,860	1.5201	3,510
1726	1,144	109	572	203	260	0				0	N/A	N/A	Y	N/A	N/A	N/A	N/A
1728	4,720	1,253		393		3,074	25	27	1	28	122.96	109.79	Y	1.0573	3,250	1.1841	3,640
1734	4,720	1,291	195	796		2,438	20	19	2	21	121.90	116.10	Y	1.0664	2,600	1.1198	2,730
1735	1,144	153	741	42	208	0				0	N/A	N/A	Y	N/A	N/A	N/A	N/A
1736	1,144	245		83	81	735	7	7		7	105.00	105.00	Y	1.2381	910	1.2381	910
1740	4,720	1,883	190	1,822	64	761	11	11		11	69.18	69.18	Y	1.8791	1,430	1.8791	1,430
1741	1,984	286		1,048	338	312	3	5		5	104.00	62.40	Y	1.2500	390	2.0833	650
1745	4,720	1,234	321	90	189	2,886	29	29		29	99.52	99.52	Y	1.3063	3,770	1.3063	3,770
1747	4,720	1,358	228	867	88	2,179	24	25	4	29	90.79	75.14	Y	1.4318	3,120	1.7302	3,770
2785	7,715	2,407		852	842	3,614	18	22	1	23	200.78	157.13	Y	0.6475	2,340	0.8273	2,990
2787	7,715	2,731	140	490	140	4,214	31	35		35	135.94	120.40	Y	0.9563	4,030	1.0797	4,550
2789	7,715	3,215	360	932	270	2,938	25	29		29	117.52	101.31	Y	1.1062	3,250	1.2832	3,770
2791	7,715	3,651		621	10	3,433	31	33	1	34	110.74	100.97	Y	1.1739	4,030	1.2875	4,420
2793	899					899	3	3		3	299.67	299.67	N	0.4338	390	0.4338	390
2795	2,844	551	146	749	152	1,246	13	10	3	13	95.85	95.85	Y	1.3563	1,690	1.3563	1,690
3308	6,681					6,681	61	63	27	90	109.52	74.23	N	1.1869	7,930	1.7512	11,700
3309	609	24		9	32	544	6	14		14	90.67	38.86	N	1.4338	780	3.3456	1,820
1914	2,360	677		100		1,583	16	20	2	22	98.94	71.95	Y	1.3140	2,080	1.8067	2,860
2717	7,017	1,094	2,879	351	293	2,400	21	25		25	114.29	96.00	Y	1.1375	2,730	1.3542	3,250
2786	1,436					1,436	14	17	5	22	102.57	65.27	N	1.2674	1,820	1.9916	2,860
2715F	3,528	756	450	840	150	1,332	19	24		24	70.11	55.50	Y	1.8544	2,470	2.3423	3,120
2716F	10,000					10,000	100	120		120	100.00	83.33	Y	1.3000	13,000	1.5600	15,600
2733	5,684	1,904	243	2,147	255	1,135	17	17		17	66.76	66.76	Y	1.9471	2,210	1.9471	2,210
635	1,676	176		225	173	1,102	7	7		7	157.43	157.43	Y	0.8258	910	0.8258	910
1204	560					560	4	3		3	140.00	186.67	N	0.9286	520	0.6964	390
1407	17,685	3,193	384	380	250	13,478	222	205	10	215	60.71	62.69	Y	2.1413	28,860	2.0738	27,950

(a) Bldg. No.	(b) Gross Admin Space (sq. ft.)	(c) Aisle & Struct. Loss (sq. ft.)	(d) Conf. Room Space (sq. ft.)	(e) Special Use Space (sq. ft.)	(f) Storage Use Space (sq. ft.)	(g) Net Office Space (sq. ft.)	(h) Actual Admin Persn.	(i) Auth. Admin Persn.	(j) Auth. Other Persn.	(k) Total Auth. Persn.	(l) Space / Actual Admin Persn. (sq. ft.)	(m) Space / Total Auth. Persn. (sq. ft.)	(n) Cat. 610xx?	(o) Actual Office Subutil. Index	(p) Actual Weight	(q) Auth. Office Subutil. Index	(r) Auth. Weight
1408	460	75		125		260	3	3		3	86.67	86.67	Y	1.5000	390	1.5000	390
1413	860	211				649	9	2	7	9	72.11	72.11	Y	1.8028	1,170	1.8028	1,170
1423	5,650	150		3,500	500	1,500	9	9		9	166.67	166.67	Y	0.7800	1,170	0.7800	1,170
1607	4,581	1,136		2,340		1,105	13	13		13	85.00	85.00	N	1.5294	1,690	1.5294	1,690
1744	2,379	894		1,188		297	6	4		4	49.50	74.25	Y	2.6263	780	1.7508	520
2745	1,895	40	192			1,663	7	7		7	237.57	237.57	Y	0.5472	910	0.5472	910
2746	5,700	380	400			4,920	23	23		23	213.91	213.91	Y	0.6077	2,990	0.6077	2,990
210	1,241	213		345		683	9	9		9	75.89	75.89	Y	1.7130	1,170	1.7130	1,170
636	2,592			2,000		592	3	3		3	197.33	197.33	Y	0.6588	390	0.6588	390
637	2,740	560	170	925	72	1,013	16	13	3	16	63.31	63.31	Y	2.0533	2,080	2.0533	2,080
638	1,600			1,000		600	3	3		3	200.00	200.00	Y	0.6500	390	0.6500	390
639	2,432	250	241	530	26	1,385	14	19		19	98.93	72.89	Y	1.3141	1,820	1.7834	2,470
657	646					646	7	5	2	7	92.29	92.29	N	1.4087	910	1.4087	910
667	2,578	668	126	660		1,124	19	18	1	19	59.16	59.16	N	2.1975	2,470	2.1975	2,470
627	4,720	1,180		102		3,438	23	23		23	149.48	149.48	Y	0.8697	2,990	0.8697	2,990
711	1,120					1,120	17	17		17	65.88	65.88	N	1.9732	2,210	1.9732	2,210
1410	4,050	624	281	169		2,976	17	20		20	175.06	148.80	Y	0.7426	2,210	0.8737	2,600
2750	1,259					1,259	10	10		10	125.90	125.90	N	1.0326	1,300	1.0326	1,300
664	1,290					1,290	6	8		8	215.00	161.25	N	0.6047	780	0.8062	1,040
1411	2,131					2,131	22	22		22	96.86	96.86	N	1.3421	2,860	1.3421	2,860
1506	1,600					1,600	5	5		5	320.00	320.00	Y	0.4063	650	0.4063	650
2413	1,974	578		385		1,011	9	11		11	112.33	91.91	N	1.1573	1,170	1.4144	1,430
2743	2,244					2,244	38	38		38	59.05	59.05	N	2.2014	4,940	2.2014	4,940
3708	148					148				0	N/A	N/A	Y	0.0000	0	0.0000	0
1608B	18,000	690		350	16,384	576	10	10		10	57.60	57.60	Y	2.2569	1,300	2.2569	1,300
210	1,626	284			284	1,058	18	18		18	58.78	58.78	Y	2.2117	2,340	2.2117	2,340
215	2,540	487		633	34	1,386	10	7		7	138.60	198.00	N	0.9380	1,300	0.6566	910
224	3,663	1,241	315	173	155	1,779	15	15		15	118.60	118.60	Y	1.0961	1,950	1.0961	1,950
314	2,954					2,954				0	N/A	N/A	Y	0.0000	0	0.0000	0
593	2,250					2,250				0	N/A	N/A	Y	0.0000	0	0.0000	0
661	1,886					1,886	19	6	13	19	99.26	99.26	N	1.3097	2,470	1.3097	2,470
708	2,750					2,750				0	N/A	N/A	Y	0.0000	0	0.0000	0
709	3,500					3,500				0	N/A	N/A	Y	0.0000	0	0.0000	0
808	1,238	150		450	180	458	3	1		1	152.67	458.00	N	0.8515	390	0.2838	130
1508	1,600					1,600				0	N/A	N/A	Y	0.0000	0	0.0000	0
1550	3,500					3,500				0	N/A	N/A	Y	0.0000	0	0.0000	0
1713	2,240	110	600	1,100	200	230	5	6	2	8	46.00	28.75	Y	2.8261	650	4.5217	1,040

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
Bldg. No.	Gross Admin Space (sq. ft.)	Aisle & Struct. Loss (sq. ft.)	Conf. Room Space (sq. ft.)	Special Use Space (sq. ft.)	Storage Use Space (sq. ft.)	Net Office Space (sq. ft.)	Actual Admin Persn.	Auth. Admin Persn.	Auth. Other Persn.	Total Auth. Persn.	Space / Actual Admin Persn. (sq. ft.)	Space / Total Auth. Persn. (sq. ft.)	Cat. 610xx?	Actual Office Subutil. Index	Actual Weight	Auth. Office Subutil. Index	Auth. Weight
210	5,596	920	635	1,277	129	2,635	37	37	3	40	71.22	65.88	Y	1.8254	4,810	1.9734	5,200
347	1,676	260		315	575	526	14	14		14	37.57	37.57	Y	3.4601	1,820	3.4601	1,820
630	2,164	100		1,269		795	3	3		3	265.00	265.00	Y	0.4906	390	0.4906	390
711	661					661	4	6		6	165.25	110.17	N	0.7867	520	1.1800	780
1510	1,600	305		175		1,120	12	7	5	12	93.33	93.33	Y	1.3929	1,560	1.3929	1,560
1901	3,663	200			1,000	2,463	5	5		5	492.60	492.60	Y	0.2639	650	0.2639	650
1907	3,197	200			2,000	997	4	4		4	249.25	249.25	Y	0.5216	520	0.5216	520
2408	2,644					2,644	30	29		29	88.13	91.17	N	1.4750	3,900	1.4259	3,770
2715C	5,889					5,889	57	74	4	78	103.32	75.50	N	1.2583	7,410	1.7219	10,140
2715E	766					766	1	1		1	766.00	766.00	N	0.1697	130	0.1697	130
1505	2,740	959	180	400	625	576	8	8		8	72.00	72.00	Y	1.8056	1,040	1.8056	1,040
1509	3,200					3,200				0	N/A	N/A	Y	0.0000	0	0.0000	0
1535	2,592					2,592				0	N/A	N/A	Y	0.0000	0	0.0000	0
1553	2,592					2,592				0	N/A	N/A	Y	0.0000	0	0.0000	0
1733	4,451	301		863	2,536	751	5	5		5	150.20	150.20	Y	0.8655	650	0.8655	650
210	6,912			489		6,423	49	39	10	49	131.08	131.08	Y	0.9917	6,370	0.9917	6,370
662	19,506					19,506	167	165	17	182	116.80	107.18	N	1.1130	21,710	1.2130	23,660
592	2,250	680	200	789	70	511	3	3		3	170.33	170.33	Y	0.7632	390	0.7632	390
210	12,389	2,298	1,485	6,439		2,167	23	14	5	19	94.22	114.05	Y	1.3798	2,990	1.1398	2,470
218	814					814	6	6	3	9	135.67	90.44	N	0.9582	780	1.4373	1,170
2783	2,844	743		864	41	1,196	10	10		10	119.60	119.60	Y	1.0870	1,300	1.0870	1,300
630	2,570	107	210			2,253	13	15		15	173.31	150.20	Y	0.7501	1,690	0.8655	1,950
1706	4,720	1,180		600	120	2,820	19	25		25	148.42	112.80	Y	0.8759	2,470	1.1525	3,250
1519	2,971	43	310	638	210	1,770	6	6		6	295.00	295.00	Y	0.4407	780	0.4407	780
214	2,540	223		690	70	1,557	16	14		14	97.31	111.21	Y	1.3359	2,080	1.1689	1,820
320	3,603					3,603	34	34		34	105.97	105.97	N	1.2268	4,420	1.2268	4,420
2733	4,815	2,108		246		2,461	19	19		19	129.53	129.53	Y	1.0037	2,470	1.0037	2,470
670	7,152	1,611	435	1,454	99	3,553	21	19	2	21	169.19	169.19	Y	0.7684	2,730	0.7684	2,730
1513	4,720					4,720				0	N/A	N/A	Y	0.0000	0	0.0000	0
2732	9,251	1,766		3,617	80	3,788	27	27		27	140.30	140.30	Y	0.9266	3,510	0.9266	3,510
1748	4,720				2,440	2,280	30	35	3	38	76.00	60.00	Y	1.7105	3,900	2.1667	4,940
1749	4,720				2,250	2,470	31	33	3	36	79.68	68.61	Y	1.6316	4,030	1.8947	4,680
632	4,720					4,720				0	N/A	N/A	Y	0.0000	0	0.0000	0
1704	1,165	40	400	40	60	625	6	6		6	104.17	104.17	Y	1.2480	780	1.2480	780
1712	4,720					4,720				0	N/A	N/A	Y	0.0000	0	0.0000	0
1969	2,592	260		150	100	2,082	15	15		15	138.80	138.80	Y	0.9366	1,950	0.9366	1,950
1709	3,200					3,200				0	N/A	N/A	Y	0.0000	0	0.0000	0

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
Bldg. No.	Gross Admin Space (sq. ft.)	Aisle & Struct. Loss (sq. ft.)	Conf. Room Space (sq. ft.)	Special Use Space (sq. ft.)	Storage Use Space (sq. ft.)	Net Office Space (sq. ft.)	Actual Admin Persn.	Auth. Admin Persn.	Auth. Other Persn.	Total Auth. Persn.	Space / Actual Admin Persn. (sq. ft.)	Space / Total Auth. Persn. (sq. ft.)	Cat. 610xx?	Actual Office Subutil. Index	Actual Weight	Auth. Office Subutil. Index	Auth. Weight
705B	96,673	13,907	1,671	27,081	1,389	52,625	505	573		573	104.21	91.84	Y	1.2475	65,650	1.4155	74,490
1538	2,592	168	168	168	1,625	463	8	3	5	8	57.88	57.88	Y	2.2462	1,040	2.2462	1,040
1544	1,092	399		78	119	496	5	5		5	99.20	99.20	N	1.3105	650	1.3105	650
2731	4,152	1,431	165	1,493		1,063	10	10		10	106.30	106.30	Y	1.2230	1,300	1.2230	1,300
TOTALS	749,246	110,072	19,972	124,326	60,235	434,641	3,359	3,436	254	3,690	129.40	117.79			436,670		479,700
														Actual		Auth.	
													Installation Utilization Indexes =	100.47		110.37	

Appendix D: Overall Adjustment Factors

The overall utilization rating for an installation would be expressed in terms of a percentage. The final rating would reflect the use of adjustment factors designed to account for spaces used under special circumstances. This appendix discusses some special circumstances related to four types of installation space: (1) administrative, (2) barracks, (3) warehouse, and (4) training areas. Each type of space requires an adjustment factor to most accurately reflect an installation's overall space utilization rate. Without adjustment factors, the overall utilization rates could be misleading.

Other types of space not discussed here would also need adjustment factors in a fully developed space utilization methodology. The four types of space discussed below were selected for illustration purposes because they are among the most common.

One author derived a number of his ideas for adjustment factors—especially for warehouses—from Army regulations and related criteria documents.

Adjustments for Administrative Space

Administrative space at Army installations is measured on the basis of 130 sq ft per person. An 85 to 100 percent utilization factor is considered optimal based on an open-space office plan. However, an adjustment is sometimes required because administrative space does not always occupy an open plan. For example, some administrative functions may be housed in a building that has been diverted from its original design or in a building composed of individual offices. That is, the building may have built-in structural constraints that prohibit optimal utilization for administrative functions. A constraint such as walled-in 200 sq ft rooms would require an adjustment factor, because at 130 sq ft per person it would either be considered underutilized with one person or overutilized with two people. Therefore, some method of adjustment should be employed to ensure that special circumstances be taken into consideration. A possible method is outlined in this appendix. However, individual installations may modify the suggested adjustments to fit any specific variance as needed.

Adjustments for Warehouses

Warehouse space is measured on the basis of two criteria. A density of 15 sq ft per short ton is considered good, and a factor of 85 percent of the total covered is considered optimally utilized. Adjustments may be necessary for a number of reasons, such as floor loading capacity. If 15 sq ft per short ton is too heavy or too light for a warehouse, a factor of increase or decrease is needed to better approximate the actual utilization of the facility. Accessibility is another factor in the utilization of warehouse space. Even if the floor load is not a problem in storing a particular item, the necessary equipment required to load and unload the item may not be available, which could decrease the maximum storage capacity available. Similarly, the load capacity must be considered if the stored item is to be stacked. For example, jeeps are often stacked in storage. Although individual jeeps have a load capacity lower than that of the floor loading capacity of the warehouse, a stack of jeeps could be higher than the load capacity. An adjustment factor may be needed to compensate for what appears to be an underutilized warehouse, because in fact, the warehouse may be utilized to its fullest potential. All Army Materiel Command (AMC) space, regardless of actual current status, was considered optimally utilized for the purpose of this study.

Adjustments for Barracks

Barracks space is measured on the basis of unit per rank, with the lowest rank receiving one unit and higher ranks receiving a multiple greater than one unit. An adjustment factor may be needed for barracks if they are vacated for maintenance reasons. Adjustment may be required also in the case of a temporary transfer of troops for war games. Adjustments in these cases should be based upon the number of units used during normal occupancy. A utilization rate of 85 percent to 100 percent is considered optimal.

Adjustments for Training Spaces

Training space is measured on the basis of seating capacity and time occupied. A rate of 85 percent occupied 70 percent of the time is considered optimal. The 100 percent utilization time rate is 40 hours per week. Reasons for adjustment factors for this space this space type may include a need for more space in computer classes and other lab-type instruction spaces.

Overall, the rate of 85 percent to 100 percent is considered optimally utilized. However, it should be noted that this represents 85 percent of the usable space, and

space that has been diverted to another use is not included in usable space. Table D1 shows the basic utilization rate categories.

Table D1. Basic utilization rate categorization.

Rate	Description
> 100%	Overutilized
85% – 100%	Optimally utilized
< 85%	Underutilized
< 10%	Not utilized

Abbreviations and Acronyms

AMC	Army Materiel Command
BRAC	Base Realignment and Closure
DA	Department of the Army
GIS	geographic information system
HQDA	Headquarters, Department of the Army
HVAC	heating, ventilating, and air conditioning
ICARPUS	*Installation Commander's Annual Real Property Utilization Survey*
MACOM	major Army command
RAM 1	Ratio Analysis Method 1
RPMP	Real Property Management Program
USACERL	U.S. Army Construction Engineering Research Laboratories
USACPW	U.S. Army Center for Public Works

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